# Scientific News

## FOR GENERAL READERS.



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## NOTES OF THE MONTH.

Provincial Meetings of the Societies.—Edinburgh, Manchester, and Newcastle-on-Tyne will be the centres round which the chief Scientific Societies of England will this year hold their summer or autumn meetings. The Institution of Mechanical Engineers will visit the Scottish capital in the first week in August, when the chief attractions will be the excursions to the Forth and Tay Bridges. A passing visit will also be paid to Newcastle on the return south, so as to afford an opportunity of examining the exhibition to be held there. The British Association will make Manchester their head-quarters in September, when the usual extensive programme of meetings and excursions will doubtless occupy the attention of members. The Institution of Naval Architects, encouraged by the great success of last year's visit to Liverpool, will hold a summer meeting towards the end of July or early in August near the home of their president, Lord Ravensworth, on the banks of the Tyne; where a very full programme is being planned. The arrangements are not yet complete, but we believe the matter is as good as settled, with the exception of some minor details. The Members of the Iron and Steel Institute, who, like their neighbours the Mechanical Engineers, did not go out of Town at all last summer (although the latter made a trip to Leeds in the autumn), will also visit the city of their president, Mr. Daniel Adamson, whose works at Manchester will doubtless afford one of the most interesting of the excursions. The meeting will be held on the 14th, 15th, and 16th of September, and will be immediately followed by the British Association meetings in the same city. Amongst the proposed excursions for the Iron and Steel Institute meeting are Messrs. Platt Bros.' vast engineering establishment at Oldham, Byer Peacock and Co.'s Locomotive Engine Works, and the Broughton Copper Works; but these are only the first ideas, and there are boundless possibilities in the neighbourhood. There is also a proposal to make a trip to Lincoln. Those scientific enthusiasts who like to temper their instruction with amusement will therefore be able to enjoy a very long picnic in the country this year, beginning with the Naval Architects at Newcastle and ending with the Iron and Steel Institution at Manchester.

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War and Invention is the title under which our contemporary, the *Scientific American*, in view of the possibility of war between two or more of the great European powers, calls attention to the immediate effect of such a war upon American interests. Leaving others to deal with its influence upon grain, petroleum, cotton, and general manufactures, the *Scientific American* gives the first place in war-invention to "engines of war, their equipment, and their auxiliary attachments," followed by inventions relating to "forts, armour, floating batteries, and guns, carriages, and shields for harbour protection." Reference is made to the probable change of small arms in nearly all countries, and then follows this paragraph :—"The improvement of heavy ordnance, armour, shells and other projectiles, fuses, ammunition, and fortifications, offers a wide field. Similarly the construction of ships, armour-clads, fast cruisers, rams, torpedo craft, and floating batteries, presents opportunities for novel designs and valuable invention, such as could make the fortunes of scores of inventors. All the varieties of mechanical contrivance needed for driving and working ships, pumping, steering, lighting, handling shot, shell, and torpedoes, and loading and pointing the heavy guns—all these openings for inventive talent are made more accessible to inventors by the outbreak of war."

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Explosive substances are specially referred to, and it is remarked that a great deal is still uncertain as to the proper charge of gunpowder for both ordnance and small arms, it being claimed that even in field-pieces a considerable quantity of the powder is wasted by being blown out of the gun unconsumed. Many other subjects are mentioned, but the above will suffice to show that, although the United States may not be within measurable distance of being mixed up in European conflicts, Americans are nevertheless keenly alive to the very direct interest they have in applying their inventive powers to the requirements of European war.

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The Horse Power of a Whale's Tail affords a fruitful and interesting subject for speculation, but it would not, at first sight, appear to be one especially suitable for a Professor of Anatomy to enlarge upon before the members of a Philosophical Society. However, Sir William Turner, the eminent Edinburgh anatomist, has lately delivered a lecture on whales and their structure, and some details from this have been quoted in a recent number of *Engineering*. In the course of his remarks the Professor dwelt on the speed attained by the whales, and this branch of the subject naturally led him to speculate on the power required to propel these monsters of the deep at the speed they are estimated to attain. Accordingly, Sir William summoned to his aid a well-known naval architect, in the person of Mr. John Henderson, of Glasgow, the designer and builder of some of our most important Atlantic liners. The following are briefly the results arrived at by this combination of expert knowledge. It has been estimated that a Greenland right whale, 50 to 60 feet long, will travel at the rate of 9 to 10 knots an hour, but finner-whales will swim at higher rates of speed, whilst the sperm whale will propel itself 12 knots in an hour. Whales, 80 feet in length, frequently visit British waters, one of this size being stranded at Longniddry a few years ago. It weighed 74 tons, and its tail measured 18 to 20 feet across the flukes. Assuming this leviathan travelled at the higher rate of speed mentioned (12 knots) it would, according to Mr. Henderson, develop 145 horse power. When we remember how wide of the mark ship-designers often are in their estimates of powers required to propel ships at given speeds, and this in spite of the accumulated experience of years, it would appear somewhat strange that one of their number should forecast, with any show of confidence, the power necessary to drive fishes or marine animals through the water.

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The constants by which naval architects attempt to formulate a relation between powers and speeds in ships are quite untrustworthy beyond ordinary ranges of speed, as is too often proved by the unexpected results of trial trips of new types of vessels, where the "grand old rule of thumb" is not available through lack of data. It would therefore appear somewhat bold for Mr. Henderson to have hazarded his assumption as to the whale's expenditure of power; but, as a matter of fact, he is quite as likely to be correct when theorizing about whales and their tails as about ships and their engines. The modern theory of the resistance of ships divides the subject into three sections, viz. (1) frictional resistance due to the gliding of the water in contact with the submerged part of the vessel, (2) eddy-making resistance, and (3) surface disturbance, or wave-making resistance. Of these the second is generally of small importance, and it is the latter which is the great unknown quantity when speeds not now considered excessive are reached. Obviously in the case of a whale, swimming at some depth in the ocean, there would be no appreciable surface disturbance, and Mr. Henderson, therefore, had his problem much simplified. Indeed, were the ocean composed of a perfect fluid—and eliminating some other considerations which militate against theoretical results being obtained by the whale in actual practice—a naval architect could calculate the power required to set the animal in motion with exactitude, but, as such conditions do not exist in nature, it would be interesting to have more of the details on which Mr. Henderson based his estimate.

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Could the Original Reis Telephone Speak?—We do not intend to usurp jurisdiction on telephone patents. But so much is certain that Philipp, Reis of Friedrichsdorf, near Homburg, invented in 1860 an apparatus which he called a telephone; and that Bell 1879 patented an instrument which he did not call a telephone, but which is claimed to be *the* telephone. The original Reis telephone passed into the possession of Dr. Stein, of Frankfort-on-the-Main; Dr. Stein sent it to Professor Silvanus Thompson, who has broken a lance for Reis in his book: "Philipp Reis, the Inventor of the Telephone." Thompson sent it to the Overland Telephone Co., and many experiments have since been made with the original instrument in America, where Professor Houston has exerted himself to ascertain the opinions of the various scientists regarding the invention of the telephone. The great question is: Could the original Reis telephone speak? Dr. Stein says no; and Mr. Paddock says yes. He tried it and found it spoke tolerably well, sometimes; although the *s*, *h*, and *j* would never come out distinctly. Others failed; but Professor F. Nipher, of St. Louis, has shown that it is simply a question of properly stretching the membrane. If Dr. Stein can't make the telephone speak, argues Professor Houston, it is not Reis' fault. The controversy has for some time been carried on in the *Journal* of the Franklin Institute of Philadelphia, and the January number of this publication brings again an interesting contribution to the question.

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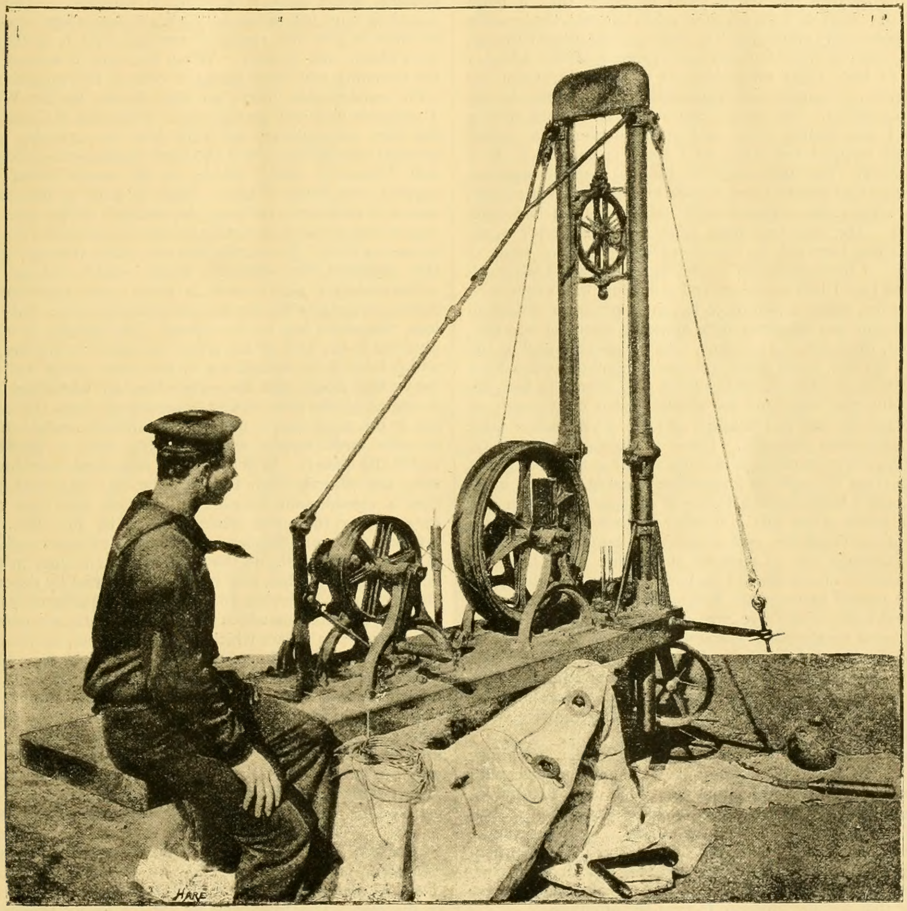
Analysis and Insurance.—Two barns, said to be filled with unthrashed wheat, were recently burned in Germany. They were insured, but the insurance company refused to pay, alleging that the contents of the barns were simply straw. The affair was taken into court, and chemical experts were called in to analyse the ashes. Wheat contains a large quantity of phosphoric acid, almost ten times as much as straw. The experts found that of two samples placed in their hands, one contained 10·2 per cent. and the other 19 per cent. of the acid, thus proving that the farmers were right and the insurance companies wrong.

## DEEP-SEA SOUNDING.

WHEN our fathers, regardless of expense, made deep-sea sounding-lines of silk, they possibly thought that the maximum limit of strength with a minimum of weight had been reached. How far such a supposition would be from the truth may be gathered when we remember that a cast of about four thousand fathoms has been made with a line only twenty-eight thousandths of an inch in diameter, and having a tensile strength of over 200 lbs.; sometimes, indeed, being capable of supporting a weight of 240 lbs. Of course there is but one substance known from which such a line could be made, and that is steel which has been subjected to the process of wire-drawing. The way in which the tensile strength of some metals is increased by drawing through a die, as in the ordinary process of making wire, is amongst those remarkable phenomena which still remain for science to explain. It is a question which we need not stop to discuss now, but it may be interesting to state, as the subject we are treating of depends on the high tenacity of a steel wire, that Dr. Pole, in a letter to Dr. Percy, the President of the Iron and Steel Institute, refers to a fine steel wire (·030 inch diameter) which had the marvellous breaking strain of 169·9 tons to the square inch.

A material of such a tensile strength is only the product of modern science skilfully applied to a manufacturing industry, and the use of such a wire, even when made for sounding purposes, has been surrounded by so many difficulties, that mariners of a past generation may well be excused for not having contemplated its use.



THE SIGSBEE SOUNDING MACHINE.

To Sir William Thomson we owe this forward step in the march of scientific investigation; for it was in the Bay of Biscay, in 1872, and from the deck of his schooner-yacht, the *Lalla Rookh*, that steel wire was first used for plumbing the depths of the sea. We cannot do better than quote the great physicist's own words in describing the incident:—"I had sounded," Sir William said, in a communication which we abridge from the *Nautical Magazine*, "from the *Lalla Rookh*, in the Bay of Biscay, with a lead weight of 30 lbs., hung, by 19 fathoms of cod-line, from another lead weight of 4 lbs., attached to one end of a three-mile coil, made up of lengths of pianoforte-wire spliced together, and wound on a light wheel, about a fathom in circumference, made of tinned iron plate. My position at the time was considerably nearer the north coast of Spain than a point where the chart shows a depth of 2,600 fathoms, the greatest depth previously marked on the charts of the Bay of Biscay. When 2,000 to 2,500 fathoms were running off the wheel, I began to have some misgivings as to the accuracy of my estimation of weights and application of resistance to the sounding-wheel. But after a minute or two more, during which I was feeling more and more anxious, the wheel suddenly stopped revolving, as I had expected it to do a deal sooner. The impression on the men engaged was that something had broken; and nobody on board, except myself, had, I believe, the slightest faith that the bottom had been reached. The wire was then hauled up, and, after 1,000 fathoms had been got in, the wheel began to show signs of distress. I then perceived for the first time (and I felt much ashamed that I had not perceived it sooner) that every turn of the wire, under a pull of 50 lb., must press the wheel on two sides of any diameter with opposing forces of 100 lbs., and that, therefore, 2,240 turns, with an average pull on the wire of 50 lbs., must press the wheel together with a force of 100 tons, or else something must give way. In fact, the wheel did give way, and its yielding went on to such an extent that the last 500 fathoms and the 30 lb. sinker were got in with great difficulty. I was in the greatest anxiety, expecting every moment to see the wheel get so badly out of shape that it would be impossible to carry it round in its frame, and I half-expected to see it collapse altogether and cause a break of the wire. Neither accident happened, and, to our great relief, the end of the wire came above water, when instantly the 19 fathoms of cod-line were taken in hand, and the sinker hauled on board. I scarcely think any one but myself believed the bottom had been reached, until the brass tube, with valve, was unscrewed from the sinker, and showed an abundant specimen of soft, grey ooze. The length of wire and cod-line which had been paid out was within a few fathoms of being exactly 2,700 fathoms. The wire was so nearly vertical, that the whole length of the line cannot have exceeded the true depth by more than a few fathoms."

Since the possibility of using steel wire for soundings was thus proved, the system has been introduced with success in a variety of situations, such as scientific investigation (notably during the *Challenger* expedition), cable-laying, and hydrographic work generally. By no one, however, has the system been carried to greater perfection than by the officers of the United States Coast and Geodetic Survey Department; and it is to labours of American enquirers that we now propose to turn our attention.

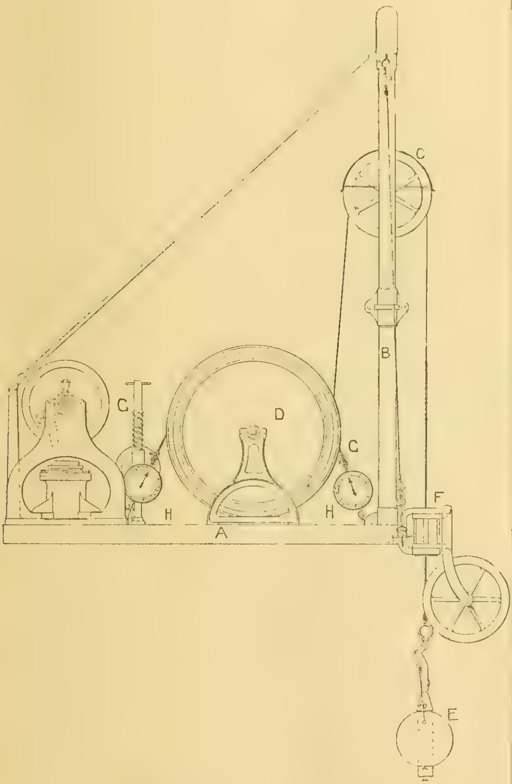
The sounding apparatus originally devised by Sir William Thomson was, it is hardly necessary to say, excellently planned to answer the purpose for which it was required. At the same time it was necessarily capable of higher development, and was afterwards improved by Sir William himself. We do not propose to follow the successive stages through which the apparatus passed, but will at once proceed to describe the sounding machine of Captain Sigsbee, of the United States Navy, illustrated on pp. 3 and 5. The first of these illustrations is a perspective view of a Sigsbee sounding machine, rigged for reeling in. It is taken from a photograph kindly furnished by the U.S. Coast Survey Department. This, it will be seen, has not a steam engine fitted to it, but the other illustration shows a side elevation of a similar machine, with a small oscillating steam engine attached. This illustration is taken from a drawing, for which we are indebted to the United States Fish Commission.

In sounding with wire, the great thing to guard against is kinking. Every one knows how a piece of springy wire, if straightened out after it has been wound on a reel, will immediately assume the form of a coiled spring when the tension which held it straight is released. The steel sounding wire has necessarily a high percentage of carbon, in order to give the required strength, and it is therefore very elastic and springy. When the wire is wound in on the sounding reel, after taking a cast, it is wrapped round with considerable force, as was shown by Sir William Thomson's first reel giving way. From this it follows that the wire must always be kept taut—to use the proper nautical expression—for if the least slackness be allowed it will "throw a turn," which, on the strain being again applied, will form a kink. Such a kink is invariably a source of weakness, reducing the strength of the wire about 75 per cent. or more, and therefore always leads to a breakage sooner or later. If soundings were taken from an immovable platform, the difficulty might readily be met; but unfortunately a ship's deck is never even approximately stationary, unless the sea be exceptionally calm. This problem, therefore, has to be solved. The weight, or sinker, attached to the end of the wire—or rather to the stray line which in turn is spliced on to the wire—must not be so heavy that it will part the wire when an additional strain is caused by the ship rolling or scending* from the sinker; but at the same time it must be of sufficient weight to keep the wire under tension when the ship rolls or pitches towards the sinker. In the original sounding machine† the wire ran directly from the reel into the sea, and therefore a considerable surplus of strength over that necessary to bear the mean stress had to be provided. The problem Captain Sigsbee set himself to solve was how to equalize the strain on the wire, and the manner in which he accomplished this will be best explained by describing his machine. Referring to the outline drawing on page 5, A is the bed-plate on which the operative parts are mounted, B is one of two pillars which support a frame, on which the pulley (C) runs. The perspective view on page 3 plainly shows both pillars. D is the reel or drum on which the wire is wound. The outline drawing shows the machine rigged for paying out, whilst the perspective view shows it arranged for reeling in. The paying out is naturally the first operation, and we will therefore describe that to begin with. The stray line having been spliced to the wire, the former is passed over the pulley (C) through a swivelling fair leader chock (F). The weight, or sinker (E), is then attached. The next operation is to reeve the brake, or friction-line; a portion of the apparatus which plays an important part in the working. It is marked G G in the drawing, and passes over a score attached to the outer rim of the reel. The two balances (H H) are for showing the brake-power applied by the line, and are not absolutely necessary to the working of the machine, so their presence may be ignored for the present. The line is next rove under a small pulley at the foot of the pillar. This is shown partly by dotted lines. It next passes upwards between the pillars, and is again rove through a small pulley on the lower part of the frame in which the sounding wire pulley (C) is mounted. From thence it descends and is made fast

* Scending is the upward motion of the ship in a fore and aft direction.

† This machine was illustrated on p. 41 of the twentieth volume of *Engineering*.

to the base-plate, either first passing through a second pulley at the base of the pillars, or not, as the case may be. The object of rigging the brake-line in this manner is to obtain automatically a varying brake-power which will be in unison with the greater or less strain on the wire. Before explaining how this end is attained, it will be necessary to describe another part of the machine. The pulley (C) is mounted in a frame, as may be seen by the perspective view. This frame is arranged to slide up and down between the pillars, suitable guides being provided for the purpose. The pillars themselves are hollow, and each one




contains a long spiral spring, which is fastened at its lower end to the bottom of the pillar. In connection with these springs a light line is rove in the following manner. It is attached to the top end of one spring, passes up and over a pulley on the top of the corresponding pillar, then downwards and through a small pulley on the top of the main pulley frame, then back over a second pulley on the top of the other column, and is finally made fast to the second spiral spring inside that column. It will be seen that this cord will serve to hold the sliding pulley frame in its highest position, *i.e.*, at the top of its range of motion, and the length of the cord is adjusted as to give this position when the springs are not extended. Before commencing to pay out, the friction cord is hauled down, so as to put a very appreciable brake power on the reel.

By connecting the description of the arrangement of brake line and that of the spiral springs, it will be seen that an additional strain on the sounding wire, caused by the vessel rolling from the sinker, will pull the pulley C and its sliding frame downwards. The movement will vary as the strain, being controlled by the spiral springs in the pillars. The downward movement of the pulley frame will have the effect of slacking the brake cord, which is rove throngh a pulley on the frame's under part. The friction on the wheel being thus reduced, the wire will pay out faster, and any undue strain will be avoided. When the ship turns to roll towards the sinker, the strain on the wire is reduced, and if this is continued far enough, the wire will become slack, and the fatal kink will be made. This, however, is obviated by an opposite train of events to those just described. Reduction of strain on the wire will allow the spiral springs, by their reaction, to draw the pulley-frame upwards, and this will tighten the brake cord, so that the wire will pay out very slowly. It is, however, when the sinker strikes the bottom of the ocean that the chief function of the friction cord comes into play. When this occurs a great part of the strain is at once taken off the wire, and were there no brake the reel would continue to fly round by its acquired momentum, and the wire would become so slack that there would be a number of turns at once formed. When, however, the weight is supported by the ground, the spiral springs are relieved from strain, and by their reaction carry the pulley-frame up so that the brake is at once applied, in the manner already described, and the reel is brought almost immediately to rest, only a short length of the stray line lying loosely on the bottom. The extreme end of the wire, where it joins the stray line, is weighted just enough to keep the wire out of turns when the whole apparatus is at rest. These weights are not sufficient to overcome the resistance of the friction line. It will be seen, therefore, that the spiral springs and the friction line act as an accumulator to equalise the strain, and as a governor to prevent undesirable speed of unwinding.

The number of fathoms of wire paid out is shown by means of a counter placed either on the reel or on the pulley C. In the former case allowance has to be made for riding turns. The beautiful device of Sir William Thomson's, by which a given depth of water is registered through the varying pressure at different depths compressing air, may of course be used with this apparatus, but in taking deep soundings the vessel is stopped, and there is so little friction from passing undercurrents, ordinarily met with, that the wire approaches a vertical line sufficiently for all practical purposes.

In our illustration on this page a detachable sinker, E, is shown. This is automatically released by a trigger arrangement, and left at the bottom, the brass sounding rod which passes through it being alone recovered. It is found cheaper to throw away the iron sinker, rather than expend the time required in the slower winding necessary when recovering it; that is unless sounding in comparatively shallow waters, when a lead sinker is used.

The bottom having been reached, the operation of winding in commences. A gut belt is put on the fly wheel of the small engine, shown at the rear of the machine in the outline drawing, and passes round a score provided for it on the periphery of the reel. The friction cord is cast off, and the winding-in progresses, the accumulator springs in the pillars, preventing sudden jerks from the movement of the vessel. The pulley marked H is for keeping the belt at tension to prevent slipping. For this purpose it is mounted on a sleeve, which slides on the standard, and is pressed down by the spiral spring, as shown.

## THE INFLUENCE OF ELECTRIC LIGHT ON VEGETABLE GROWTH.

AMONG the many subjects which engaged the attention of the late Sir William Siemens was the influence of the electric arc light on vegetable growth, and his communications to the Royal Society, in March, 1880, and to the British Association, in September, 1881, were extremely interesting.

In the former, he stated that he had been struck with the abundance of actinic rays in the electric arc, upon which its value in photography depends; and he had noticed also, when experimenting with powerful electric lamps, that the skin was often blistered without the sensation of excessive heat; an effect similar to that produced by solar rays in a clear atmosphere. This led him to make experiments to ascertain whether electric light exercised any decided effect upon the growth of plants, and for this purpose he placed an arc lamp with a metallic reflector in the open air, about two metres above the glass of a sunk melon house. Pots containing quick-growing seeds and plants, such as mustard, carrots, beans, cucumbers, and melons, were arranged so that they could be brought at suitable intervals under the influence of daylight and electric light, without moving them, both lights falling approximately at the same angle. The pots were divided into the following groups :—

1. One pot of each group was kept entirely in the dark.
2. One was exposed to the influence of the electric light only.
3. One was exposed to the influence of daylight only.
4. One was exposed successively to both day and electric light.

For groups 2 and 4 the electric light was supplied for six hours, from 5 to 11 each evening, all the plants being left in darkness during the remainder of the night.

In all cases the differences of effect were said to be unmistakable. No. 1 plants were pale yellow, thin in the stalk, and soon died. No. 2 shewed a pale green leaf, and had sufficient vigour to survive. No. 3 were of a darker green and greater vigour. No. 4 shewed a decided superiority in vigour over all the others, and the green of the leaf was of a dark rich hue. Sir William adds: "It must be remembered that, in this contest of electric against solar light, the time of exposure was in favour of the latter in the proportion of nearly two to one, but all allowance made, daylight appeared to be about twice as effective as electric light. It was evident, however, that the electric light was not well placed for giving out its power advantageously. The nights being cold, and the plants under experiment for the most part of a character to require a hot, moist atmosphere, the glass was covered very thickly with moisture, which greatly obstructed the action of the light, besides which, the electric light had to pass through the glass of its own lamp." The loss of effect being, therefore, considerable, experiments were made with the electric lamp placed inside the glass-house, and some of the general conclusions arrived at were as follows :—

1. Under the influence of electric light, chlorophyl [the green colouring matter] is formed in the leaves of plants, and their growth is promoted.

2. An electric centre of light, equal to 1,400 candles, placed at a distance of two metres from growing plants, appeared to be equal in effect to average daylight in the winter season, but more economical effects could be attained by more powerful light centres.

3. Plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight, and during the night to electric light.

4. While under the influence of electric light, plants can sustain increased stove heat without collapsing, a circumstance favourable to forcing by electric light.

In the same year a new set of experiments on a larger scale were commenced on Oct. 23rd, and continued till May 7th, 1881. Two electric lamps of 5,000 candles each were used, one being suspended at a height of 12ft. to 14ft. over some sunk greenhouses, and the other placed inside a glasshouse of about 2,300 cubic feet capacity. The effects produced by the outside light over the sunk houses were similar to those observed during the previous winter, but the plants in the house with the naked arc light soon manifested a withered appearance. This gave rise to various interesting experiments, but as Sir William Siemens remarks, the plants did not take kindly to these innovations in their mode of life. Finally, it was found that the effect of merely interposing a thin sheet of clear glass between the plants and the arc light was most striking. On placing such a sheet of clear glass so as to intercept the rays of the electric light from a portion only of a plant—for instance, a tomato plant—it was observed that in the course of a single night the line of demarcation was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though at a distance from it of 9 to 10ft., was shrivelled, whereas that portion under cover of the clear glass continued to show a healthy appearance. Experiments were then made with plants covered by glass of different colours, and it was found that the largest and most vigorous growth was induced under clear glass; yellow glass came next in order, then red, and finally blue. Having established the importance of surrounding the arc light with clear glass, some very good results were then obtained. Thus, peas sown at the end of October produced ripe fruit on 16th February, when continuously under the influence of light, with the exception of Sunday nights. Raspberry canes put into the house on the 16th December produced ripe fruit on the 1st March, and strawberry plants planted about the same time produced ripe fruit of excellent flavour and colour on the 14th February. Vines which broke on the 26th December produced ripe grapes of stronger flavour than usual on the 10th March. Many other examples are mentioned by Sir Williams Siemens, and he was sanguine that when the best conditions of temperature in the house, and of proximity to the electric light, had been thoroughly investigated, still better results would be obtained. Unfortunately his death put an end to these most interesting experiments, and so far as we are aware they have not since been pursued in a systematic way by any one else in this country.

During the months of August, September, October, and November, 1881, Professor Dehérain, of the Natural History Museum, Paris, conducted a series of experiments in a glasshouse erected inside the Electrical Exhibition then being held there. One half of this house was rendered completely opaque to sunlight, and the inside of this half was painted white to reflect the light from the electric lamps. The other half of the house was covered with clear glass, and various tests were made in each division. No heating apparatus was used, and the temperature of the house rose and fell with that of the external air, and was occasionally as low as 40° F. It should also be mentioned that the sunlight, which first passed through the Exhibition roof, and then through the roof of the testing house, had a very different effect on the plants from that obtainable in a house receiving the sun's rays direct. It will thus be seen that these trials were made under somewhat unfavourable conditions.

The first experiments were made with naked arc lights, and they confirmed what Sir William Siemens had previously noted, viz., that some of the rays emitted from an arc light cause the leaves to shrivel, and the plants to be otherwise injuriously affected. After this, the lamps were surrounded with clear glass, as recommended by Sir W. Siemens, and the general results are thus recorded :—

1. The electric light was unable to develop young germinating plants.

2. Vigorous plants, in full vegetation, were able to live in the darkened portion of the house, in which they received the reflected rays of the electric light both day and night.

3. None of the plants experimented on, except barley, performed its normal functions; no flower opened.

Healthy plants, under the influence of sunlight, emit a very large quantity of water (according to Professor Dehérain, a young blade of corn yields its own weight of water in one hour, and maize still more); but with an arc light this is very much less, and this he attributes to the want of red or heat rays.

In a third set of experiments, the plants were placed much nearer the electric lights. Professor Dehérain gives the results in detail, but his general conclusions were as follows:—

1. The arc light has rays which are injurious to vegetation.

2. The larger portion of the injurious rays can be arrested by transparent glass.

3. The arc light was proved to have rays favourable to vegetation, in sufficient quantity to enable plants to vegetate under its sole influence for two-and-a-half months.

These results confirm the early experiments of Sir William Siemens, but they are not nearly so good as those last obtained by him, and this is probably due to the following causes. In the first place, Professor Dehérain used lamps of about 1,500 candles' power each, whereas those last used by Sir William Siemens had each a power of about 5,000 candles, and the rays of the latter would, therefore, have greater energy and a much greater influence on the plants. In the next place, Professor Dehérain had no heating apparatus, whereas Sir W. Siemens employed the usual circulation of hot water in pipes, and there is little doubt that if the hours are increased during which a plant is stimulated with light, it is important that the temperature of the house should also be carefully regulated. Again, in the case of the plants subjected to sunlight in the daytime, and to arc lights at night, Professor Dehérain's results were doubtless influenced by the fact that he did not have the sun's rays direct. It is true that he placed some of the plants in the open air in the gardens, during the daytime, but they were then subjected to even greater variations of temperature than in the Exhibition building.

Under the influence of the sun's rays the leaves of a plant absorb and decompose carbonic acid gas, and this effect is chiefly promoted by the red or heat rays. Professor Dehérain has proved that this effect can also be produced by the rays emitted from a piece of platinum gauze highly heated. The arc light, however, differs from the sunlight, and from the usual artificial sources of light; it is much more violet and much less yellow, and has fewer heat rays. Professor Dehérain is therefore sceptical as to its being used with advantage for plants, and he recommends trials being made with electric glow lamps, or with the "*lampe soleil*" in which a piece of lime is heated to a white heat by an electric arc. Possibly he may be right, but it may be pointed out that Professor Dehérain himself proved that an arc light of 1,500 candles' power was capable of making leaves absorb and decompose carbonic acid more readily than the diffused sunlight in the Exhibition; in fact, this may be taken as a measure of its efficiency. It is true that this operation was performed much more slowly than with bright sunlight; no one however would think of using the arc light as a substitute for the sun's rays, but only as a source of light when the sun's rays are not available. It is certainly to be regretted that these trials were not made under more favourable circumstances, as no real advance has been made since the last experiments of Sir W. Siemens. If, therefore, some one who has the time and means at his disposal will pursue these investigations, he will doubtless find a very interesting, although possibly not a profitable field open to him.

## CONSERVATION OF ENERGY.

FORMERLY it was supposed that much of the energy or capacity to do work, or produce physical change, was destroyed in doing that work or producing that change. It is, however, much more in harmony with the other fundamental laws of Nature, to suppose that energy cannot be created or destroyed, any more than matter can be created or destroyed. Happily it has since been proved beyond doubt that there is no such thing as destruction of energy, but that one kind of energy is merely transformed into another kind. This, in fact, is the great principle of the Conservation of Energy, which is one of the most interesting, and at the same time one of the most important, generalisations ever made. It helps to explain the greatest questions not only in mechanics, but in chemical action, in heat and electricity, and in all subjects treated of by physical science.

Energy is now divided into two classes—the energy of motion, and the energy of position, and what this means will be understood from the following example. When a man raises a weight from the ground, or throws it upwards in the air, he does so against the force of gravity tending to keep it on the ground. The man must therefore impart so much energy of motion to the weight as will cause it to be raised, and formerly it was supposed that if the weight so raised were lodged on the top of a house or other resting-place, all the energy would have been spent. This, however, is only partly true; for although there is no longer energy of motion, seeing that the weight is at rest, it still has the power to fall to the ground with a force depending on its mass and the height of its fall. In falling, it is evident that there is again energy of motion, and the storage of this energy on the top of the house, while the weight is at rest, is called the energy of position. Again, in the case of a pendulum, when it swings from side to side, it is for an instant at rest at the end of each stroke, and then possesses the energy of position; but this again is converted into energy of motion as soon as it begins to fall. The same may be said of a spring wound up or compressed, which then has a store of energy of position capable of being transformed into energy of motion. So far it is clear that there is merely a transference of energy, and that none is destroyed; but we now have to consider other cases, a little more complicated. For instance, when a piece of iron is struck with a hammer it is heated, and when a metal button is rubbed hard it is also heated. What, then, becomes of the energy of motion in both these cases, and whence comes the heat? We may say that in the one case it is the effect of a blow or impact, and in the other of friction; but this does not help us to answer the question. Count Rumford and Sir Humphrey Davy were among the first to show that heat could be obtained by purely mechanical means, but it was left for Dr. Joule to prove by the most careful experiments that the heat thus developed was an exact equivalent of the energy expended in producing it. The apparatus he used was very simple, and consisted of blades made to revolve in a closed cylinder containing water. A falling weight attached to a cord was made to rotate the blades, and as the mass of the weight, as well as the distance through which it fell were known, the work expended in driving the apparatus was ascertained precisely. During the trial the temperature of the water in the vessel was raised owing to the friction produced by the blades, and in this way it was possible to determine accurately the quantity of heat developed with a given expenditure of power. This is known as the *mechanical equivalent of heat,* and it at once helps us to understand the presence of heat in the iron which was struck with a hammer, and in the button which was rubbed. In the case of the falling hammer, the energy of motion is converted into heat energy when the hammer is suddenly stopped by the iron. In like manner, the energy of motion used in rubbing the button is converted into heat energy. It may be that in these cases the heat produced would not be in a useful form, but it would be equivalent in quantity to the mechanical energy expended, and if the iron or button is merely left to cool it will transfer its heat energy to the surrounding air, or any body it may be in contact with. Supposing, however, that instead of these two examples we had two pieces of dry wood which were rubbed together very quickly, the heat energy developed by the friction would be so great that sparks would be given off; in fact, by this means some savages kindle their fires. The question, therefore, as to whether or not the heat is available for practical purposes in no way affects the general law of the transference of energy.

So far we have only considered the interchangeability of heat and mechanical work, but the same law holds good in all other forms of energy. For instance, electrical may be converted into mechanical energy, as when a flash of lightning destroys a church-steeple, or into heat, when a badly-arranged conductor melts during the passage of the current. A good illustration of the transformation of energy will also be found in the modern apparatus used for electric lighting. The heat energy of the fuel in the boiler is converted into mechanical energy at the steam-engine, and this in turn is converted into electrical energy at the dynamo. Finally, this is reconverted into heat and light energy at the lamp, and in each of these transformations there is, after allowing for waste due to friction and other causes, a definite equivalent for the energy expended, an equivalent which can always be accurately determined.

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Barium Hydrate from the Carbonate.—M. Hippolyte Leplay, of Paris, proposes to make barium hydrate—a body corresponding in its constitution to slaked lime—from barium carbonate, by means of superheated steam. The barium carbonate occurs as a mineral under the name of Witherite, near Alston, in Cumberland, and Hexham, in Northumberland, and many other places. Its decomposition is effected in one operation in a sort of cupola furnace; and this is the novelty of the process, somewhat similar proposals having been made by Jacquelain and Lenoir. The crushed carbonate is exposed on the hearth to fresh steam, and then becomes partially decomposed, the hydrate produced passing through a channel into an adjoining basin, separated from the carbonate by a fire-clay partition. Here the hydrate collects until it overflows the wall on the other side, which is at a little lower level, and it then passes down a slightly inclined hearth to the outlet, being all the time exposed to the action of the steam. Leaving the cupola, it flows into a basin filled with water, where the hydrate dissolves, and is afterwards concentrated by the waste heat of the steam, the insoluble carbonate which collects at the bottom being subjected to another operation.

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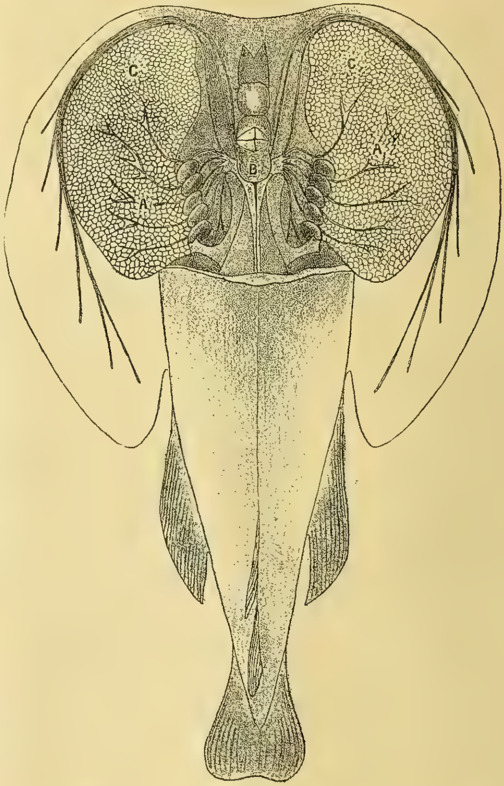
Last month the Queen of the Belgians heard by telephone, in her Palace at Brussels, an entire act of *Faust*, then being performed at the Opera House in Paris.

## THE LIVING TORPEDO.

The Torpedo Fish, like the better-known Electric Eel, is provided with very peculiar organs, by means of which it is able at will to produce a discharge of electricity sufficiently strong to paralyse fish passing over it. Thus, by rendering small fish an easy prey, it obtains a supply of food, and the organs may also serve as engines of protection from its enemies.

The accompanying sketch shows the general arrangement of the electrical apparatus when dissected out, the nerve-trunks on both sides of the fish, connecting the organ with the brain, being displayed by the removal of over-lying




parts. These nerve-trunks are marked A, the brain is indicated by B, and the mass of the electric elements by C. Each organ C is made up of a number of parallel columns, consisting of a series of elements set in rows one on the other. The elements are united with one another by connective tissue, which may be taken to represent the moist intermediate layers of the voltaic pile, and they all receive on their under surfaces branches of the nerves A, which pass into the organ. That face of the elements on which the nerves ramify is the same in all the columns, and is always electro-negative, the opposite free surface being electro-positive.

The whole apparatus bears a most striking resemblance to a voltaic battery.

## ELECTRIC LIGHT FOR NAVIGATION.

It has recently been reported that the capacity of the Suez Canal for traffic has been almost doubled since it has been lighted with arc lamps. In fact, in this great highway of the eastern and western nations, ships can now pass to and fro at night without more risk than in the daytime. It is also admitted by Sir James Douglass, the Engineer of the Trinity Board, and by other high authorities, that arc lights are, in many cases, the best for lighthouse illumination, because the light can be so clearly seen at very long distances. Moreover it is now a common practice to fit arc lamps for search lights in harbours and forts, and on board war ships, to guard against approaching vessels.

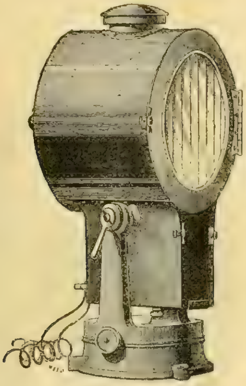


Fig. 1.

It will therefore be seen that the electric light has already lent itself to some very important applications connected with navigation by night, and the question naturally presents itself: Cannot it also be used for head-lights in ships of all kinds, so that collisions may be more easily avoided? The great power and range of the arc light are beyond doubt, and, as, by its means, an approaching vessel can be detected at a great distance, the answer eventually will doubtless be in the affirmative. In so important a matter, however, it is not only desirable, but essential, that all that can be said for and against the use of electric light for such a purpose should be carefully considered, and we shall welcome any correspondence from competent persons on the subject.

It is urged that in a strong beam of light the clearest atmosphere is bright with reflecting particles, which, to a certain extent, produce an appearance of mist or fog, and that if the arc light be placed so that the projected beam is above or on the same level as the steersman or look-out man, he must either look through the beam or along it, and so be more or less dazzled by it and unable to discern objects not immediately in the path of light. Similarly the men on the look-out in the vessel approaching the electric light will be dazzled; and further, that as they are not accustomed to such a light, they will miscalculate the distance between the two vessels. We are, however, glad to be informed by the Anglo-American Brush Electric Light Corporation that, after careful trials, they have proved that if the lamp be placed below the line of vision of the observer, and so focussed that the beam of light is not only well spread laterally, but is at the same time kept on the surface of the water, the above objections are avoided. The accompanying Fig. 1 shows the lantern used by the Brush Company, and Fig. 2 represents its effect when in use. The arrangement consists essentially of a lantern enclosing an arc lamp, having a nominal power of about 6,000 candles. A parabolic reflector is fitted in the back of the lantern, and the beam reflected from it passes through a dispersion lens, which causes the beam to be widened in the ratio of 1 to 10; for example, at a distance of 500 yards it is about 50 yards wide, and at a distance of 1,000 yards, 100 yards wide.

It is assumed that by this arrangement the beam of light will always be kept below the look-out men on either of two approaching vessels, but it should be remembered that each vessel will roll and pitch, and it does not appear to us conclusive that motion of this kind will not, to a certain extent, make good some of the objections urged against the use of electric light for this purpose. However, we cordially wish it success, and shall be pleased to hear that all reasonable objections have been entirely disposed of, as there is no concealing the fact that as the number and speed of steamers increase, there is an increasing need for avoiding the disastrous collisions with which we are but too familiar. Moreover, if electric light is used in the way suggested, there will be the further gain that, as a powerful beam will precede the ship, there will be much less risk of the latter being run on to a projecting rock or headland when coasting round a dangerous shore. In all steamers there is ample steam power to spare for driving the electrical machine, and when glow lamps are used for the saloons and cabins the same dynamo can be used for the head-light.

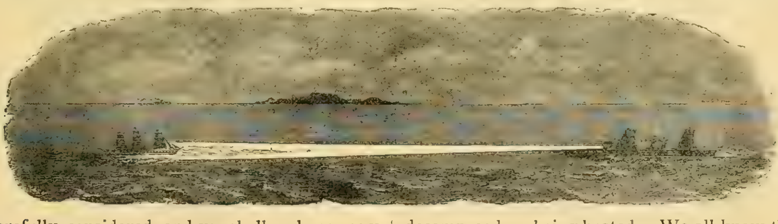


Fig. 2.

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Boiler Explosions.—M. Hocherau has started a very novel theory of the cause of boiler explosions. It appears that he attributes them chiefly to the presence of gas and air in the boiler, and to the firing of this mixture by means of an electric spark. He supposes that hydrogen, or carburetted hydrogen, is readily produced when the water in the boiler contains organic substances, especially fats, which are decomposed on being heated. We all know that air held in solution by the water is driven off in the process of ebullition, and this, he supposes, forms an explosive mixture with the gas, and it only remains to be seen how it can be fired. M. Hocherau's theory is that an electric spark may be formed by the friction of globes of steam in narrow passages, and he infers that the most dangerous moment is when the engine is started. This view he supports by showing that out of twenty-four marine boilers in which explosions had occurred, four exploded when the piston had reached the end of the stroke, and nineteen when the engines were started. Practical men will be unlikely to accept this remarkable theory without further confirmation.

Use of Cold Air for Tunnelling.—One of the most populous parts of Stockholm, that part situated north of the Lake Maelar, is crossed by a ridge of hills reaching in height to seventy feet, and fairly steep. The ordinary steps were thought neither picturesque nor convenient. It was, therefore, decided to drive a tunnel through the ridge. The greater part of this tunnel did not cause any particular difficulties; but near the western end, and just where the tunnel had to pass within a few feet of the foundations of two houses of five stories each, sand, with a clay medium, but rather permeable to water, was encountered. The water proving very troublesome, Mr. Lindmark, the engineer-in-chief, thought of refrigerating machines, which have already for several years been advantageously employed in sinking the foundations of bridges. One of Lightfoot's cold-air machines was ordered, supplying over a thousand cubic yards of air per hour, cooled down to twenty-two degrees below zero Fahrenheit. A work-chamber was partitioned off by means of a double wall of wood, the space between the wooden boards being filled with charcoal. When this chamber had been cooled for sixty hours, the ground was found frozen to the depth of five feet; the sand was also frozen a foot or more ahead, but hardly frozen above. The cold-air machine was kept going afterwards only during the night, when the temperature sank down to four and nine degrees below freezing point. For the masonry a mixture of one part of beton, one part of Portland cement, $2\frac{1}{2}$ parts of sand, and six parts of small granite was used. The work proceeded at the rate of a foot a day for about eighty days; then a firmer sand was struck, no longer necessitating the use of the refrigerator. As this refrigerating plant was thus needed for a short period only, it increased the cost of the construction, disproportionately, to a little over £20 per foot. The lineal dimensions of the tunnel are 755 feet in length, 13 feet in height, and about the same in width. Of the two houses referred to one suffered in no way, but the front wall of the other, which cannot be called a well-built house, and was not new, has sunk one inch.

Galloflavin is a new yellow dye, a German patent of the Badische Anilin und Soda Fabrik, at Ludwigshafen, on the Rhine. It is made out of gallic acid, one of the constituents of gallnuts, in a fairly simple way. The alcoholic solution of gallic acid is mixed with caustic soda or potash, less of the latter being taken than needed for saturation; the liquid becomes olive-green, and is oxidised by means of the oxygen of the air at a low temperature. The colouring matter falls out, is redissolved in hot water and decomposed by means of hydrochloric or sulphuric acid, of which up to fifty per cent. may be used. During this operation the liquid is kept boiling until the precipitating dye has become crystalline. On being then washed with warm water it needs no further preparation. Applied with a clay mordant the galloflavin imparts to the cotton fibre a greenish yellow tint; and when passed through tin salt it becomes a pure yellow, which withstands the effect of air, light, and soap, very well.

Velocity of Ocean Currents.—Admiral Bouquet de la Grye has made an interesting report to the Académie des Sciences, at Paris, on a series of experiments instituted to test the velocity of currents in the north Atlantic, by means of light water-tight casks or vessels launched into the sea at a considerable distance from the land. Some such casks, launched off the Azores in 1885, reached the land after an interval of time which indicated a daily rate of motion of from two to four miles. Later observations indicate a quicker rate of movement. Of 500 launched in deep sea off Cape Finisterre, 12 arrived at the French coast, a little below Arcachon, after an interval which suggests an average daily rate of travel of about six miles. Some of the vessels were of glass, some of copper. Those of glass, floating on the surface, were exposed more to the buffetings of the waves, as well as to the influence of the currents; so that it may not be easy to determine how much each of these factors may have contributed to the actual movement.

## THE GAS ENGINE.

Gas engines have now such a recognised position among motors, that we think a few general particulars may be useful to our readers, and at the same time we take the opportunity of discussing portions of a very useful handbook on the subject, by Mr. Dugald Clerk, which has recently been published.*

The Lenoir engine, shown in Fig. 1, and patented in 1860, was the first to emerge from the experimental stage, and although several of these engines were made in England and France, their success was not great, owing chiefly to the working expenses being excessively high. A sectional plan of the cylinder of this engine is shown in Fig. 2,† and from this it will be seen that it closely resembles a steam engine, with valves arranged to

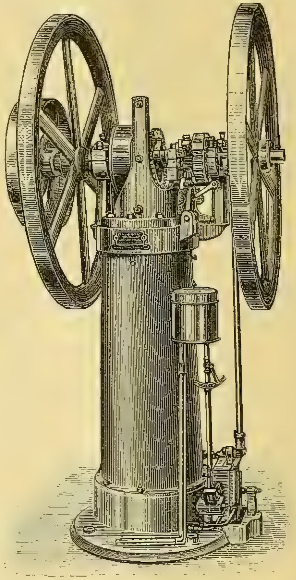

Fig. 3.

admit gas and air, and to discharge the products of combustion. The ignition of the charge was effected by an electric spark. The water surrounding the cylinder was intended to prevent the metal being over-heated, but as a matter of fact this was only partially successful, and the piston often became too hot to work. In 1867 Messrs. Otto and Langen exhibited the vertical engine shown in Fig. 3, and as its gas consumption per horse-power was only half that of the Lenoir and other engines previously made, it naturally attracted much attention, and a considerable number were sold. It was, however, extremely noisy and quite unfit for many uses. In 1876 this engine was entirely superseded by the horizontal Otto engine, now so much used. An example is given in Figs. 4 and 5, p. 13. The essential difference between the Lenoir and Otto engines is that in the former the explosive mixture of gas and air

* "The Gas Engine." By Dugald Clerk. London: Longmans, Green, and Co. 1886.

† We are indebted to the publishers of Mr. Clerk's book for permission to reproduce figs. 1, 2, and 3.

is not compressed before being ignited, whereas in the latter it is compressed to about 40 lbs. to the square inch. These engines, in fact, represent two distinct types, known as compression and non-compression engines, and Mr. Clerk, in his work, very fully discusses their relative efficiencies. We may perhaps take exception to his statement that the working fluid in all gas engines is air, whereas strictly speaking it is a mixture of air and of the products of combustion. An excess of air may be, and usually is, present, and this of course becomes heated in turn, but the high pressures developed are essentially due to the explosion or combustion of the gas. In a steam engine the working fluid is steam, produced in a separate apparatus, and in designing an engine the steam engineer has this great advantage, that the expansive fluid with which he has to work needs no mixture with air, or addition of any kind. It obeys certain well-known laws, and all that is necessary is to insure the engine being designed to make the best possible use of the fluid. With a gas engine, whether the working fluid be air, or a mixture of air and products of combustion, we have in the first place to insure complete combustion of the gas, or there will be waste of fuel, and this has to be done under somewhat difficult conditions. In the next place we have to find the best conditions of pressure and volume to insure the greatest development of power, with the least expenditure of gas. It will thus be seen that the maker of a gas engine has not only to devise the necessary mechanical contrivances, but he has to provide very specially for the treatment of the gas with which the engine is to be worked. The theoretical efficiency of a gas engine, considered as a heat engine, depends on the difference between the initial temperature produced in the cylinder when the charge is ignited, and the final temperature of the products of combustion escaping through the exhaust. The greater the difference between these temperatures the greater the efficiency. With this in view Mr. Clerk shows that by compressing the mixture of gas and air before ignition, its temperature is raised by reason of the work done upon it, and consequently there is a greater difference between the initial and final temperatures, and a corresponding increase in efficiency. In the Lenoir engine there is no compression, whereas in the Otto there is, and to this fact alone is attributed much of the superiority of the latter. This is doubtless true, but although Mr. Clerk has described the chief advantages of compression he has not stated the whole case; for instance, he has omitted to take account of the fact, that when the charge is compressed the molecules of gas are brought closer together, and are then more readily ignited; also that when so compressed they are exposed to less cooling surface in the cylinder. Both of these are important considerations, and should not be lost sight of.

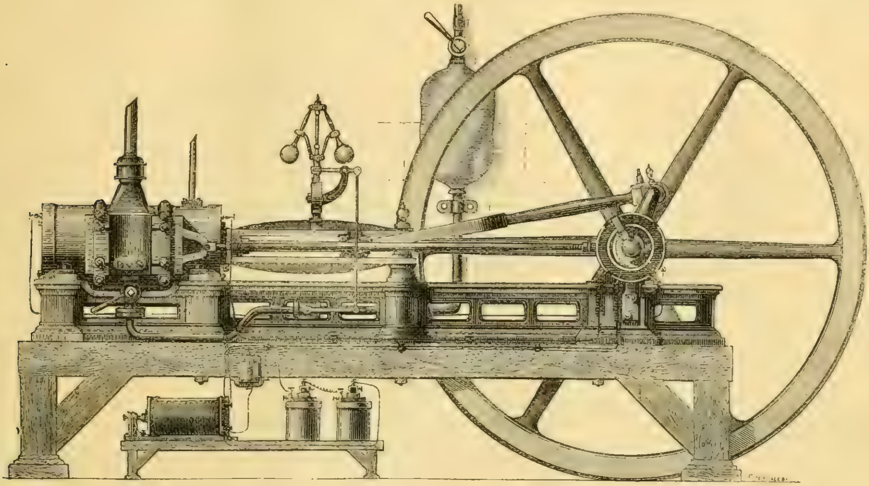

Fig. 1.

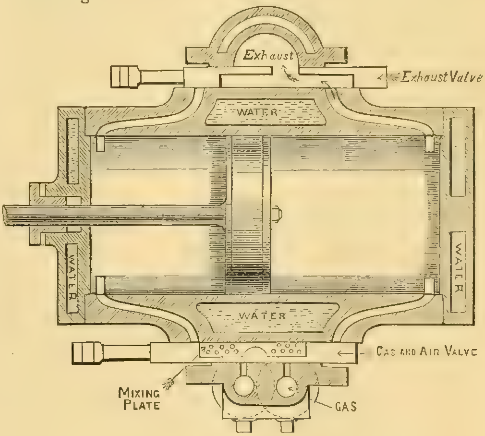


Fig. 2.

Mr. Clerk describes other engines, and gives useful details of their mechanical parts, but those we have selected may be taken as typical of the first gas engine used for practical purposes, and of the best modern engine now made. We have already seen that in the Lenoir engine there is no compression of the gas and air before ignition. The action will be readily understood by referring to Fig. 2. In the Otto engine (Fig. 5) A is the water-jacketed cylinder; B the piston when at the end of its in-stroke; and C a continuation of the cylinder forming a chamber in which the charge is compressed before ignition. On the out-stroke of the piston, gas and air are drawn into the cylinder through the port I, and on the return of the piston the charge is compressed, and then ignited through a little port or touch-hole in the slide M. As soon as the ignition takes place there is a rapid evolution of heat from the burning gases, and this induces a great increase of pressure, which acts on the piston and causes it to do useful work. As regards the efficiency of gas engines, Mr. Clerk tells us that in 1860 it was only 4 per cent., and that at the present day in the best compression engines it is 18 per cent. By this he means, that the early engine was only able to convert 4 out of every 100 heat units given to it into mechanical work, as developed in the cylinder; and that the modern compression engine can give 18 out of every 100 units as indicated work. This result is already better than can be obtained with the best steam engine, but Mr. Clerk very rightly urges further improvements, and points out where they can best be effected.

Other questions of interest are discussed, but we have sufficiently indicated the general purport of this useful little book, which we have pleasure in recommending to all who care to study the theory and practice of the gas engine—a motor so many believe capable of eventually supplanting the steam engine. The author's style is clear and concise, and the subject-matter is well-arranged, so that it is not only easy to follow the arguments on which the theoretical efficiency of the gas engine depends, but also to compare the various types of engines actually used.

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## NOTES ON COLOUR.

MR. GLADSTONE remarks in a recently published article, that "the perception of colour by the eye tells us only of our impression of the thing, not at all of the thing itself." Philosophers also instruct us that light and colour have no existence apart from the eye which sees. When we speak of the redness of a rose, we really mean that its petals have the property of reflecting certain rays of light, and that the light produces in us the sensation we call redness.

It used to be thought that "corpuscles" of light were thrown off, in a manner similar to that in which we believe the rose throws off minute particles which cause the sensation of smell; a red rose would, according to this, throw off red particles, and a yellow rose, yellow particles. It must have been obvious, one would think, that in general the light is reflected; that is to say, the source of light is not in the rose, but in the sun or lamp that illumines it. It was not, however, until Newton showed that ordinary white light can be split up into many colours, that it was easy to comprehend that the red colour of the rose is due to the property which it has of selecting the red, and reflecting it, while the other colours are lost.

There are two very common errors on the subject of "primary colours." One is, to suppose that Sir Isaac Newton discovered seven primary colours when he split up a beam of white light by means of a glass prism. It is an accident, arising, perhaps, from the poverty of our vocabulary as compared with the profusion of the tints. The so-called seven colours are, as is well known, violet, indigo, blue, green, yellow, orange, and red. The ordinary colour of indigo is not pure enough to rank among these. A more correct and complete list would be: violet, violet-blue, blue, peacock-blue, sea-green, green, yellow-green, yellow, orange-yellow, orange, orange-red, red, deep-red. Most apparently pure tints are a mixture of a group of three or four of these colours. The green of a leaf contains a small amount of violet and blue, and a considerable quantity of deep-red. The orange of a certain kind of nasturtium is nearly pure, and so is the blue of a young larkspur These tints, however, are not more beautiful on accunrt of their purity, for exactly the same apparent tint could be produced by a mixture of several colours. Pure colours are very rare in nature.

There are many seeming paradoxes in the mixtures of colours, for by this expression a mixture of pigments or paints is generally understood, and not a mixture ofrays of light.

When white light falls on a piece of coloured glass, some of it is reflected at the surface, and the rest attempts to penetrate the glass. Some of the rays succeed in getting through, and others are stopped; something, however, must become of them; they are neither reflected nor transmitted, they are dissipated in the form of heat. Those rays which get through, have little difficulty in piercing another thickness, they have, as it were, a passport for that substance. Before the light passes through it meets with the second surface, and here some of it is reflected and re-traverses the substance, a portion being again reflected at the first surface· The greater part of that which has not been absorbed passes through.

In a mass of crushed glass, the light will behave in this manner in passing the first particle, and on striking the next some of it will be reflected, and pass back through one of the upper pieces; some will strike deeper, and be reflected through several layers. The general light reflected from the whole mass will be partly white light and partly coloured. This state of things exists in all coloured bodies: they are all more or less transparent. It will be noticed that the less transparent bodies, such as turquoise, or vermilion paint, have a whitish colour, as compared with that of a sapphire or carmine paint, which are very transparent.

It is now clear that in mixing paints, we do not add the colours, but subtract them; for the light which has passed through the first particle has, in all probability, to return through another of a different kind, and only that light succeeds in traversing both which can pierce both substances. Gamboge absorbs or arrests the violet, blue, and deep-red rays, and allows a considerable quantity of green and orange light to pass. Prussian blue, on the other hand, stops the yellow, orange, and red light, and the only colour which can run the gauntlet of both pigments is the green. If a blue, which contains little or no purple, such as cobalt, and a red, such as vermilion, be mixed, the result will not be purple, but an almost neutral grey, whose lightness is due to the considerable amount of white light which is reflected by each of these paints.

Colours are said to be simple when they are to be found among those into which white light is split by a prism. There are a large number of tints which are composed of a pure colour and white, such as pink, lemon-yellow, turquoise-blue, and a corresponding set of mixtures with black, such as the browns, sage green, and indigo. One colour remains, which is not a simple colour, nor a mixture with white or black: this is purple, which is a compound of blue or violet and red. It has been calculated by Aubert that there are at least one thousand distinguishable simple colours, and about a hundred variations of the strength of a colour, and twenty different mixtures with white, making, together with the purples, browns, slate colour, and other impure mixtures, between two million and three million different tints. What a field for the artist and the milliner! Roget only gives about one hundred and seventy names in his "Thesaurus," and perhaps there are not more than two hundred names for colours in the English language. It has been proposed to make a standard catalogue of colours which could be referred to by manufacturers and dyers.

The second popular error, and one which it is very difficult to eradicate, is that there are three primary colours—red, yellow, and blue. This theory was supported by Sir David Brewster, whose optical discoveries gave him considerable claim to be heard. The common argument is,

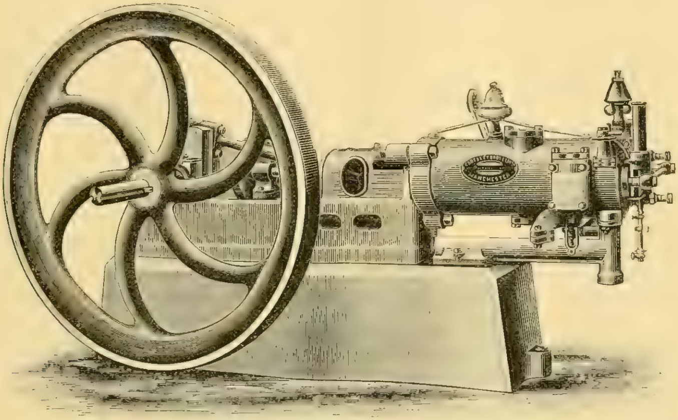

Fig 4.

"You cannot make either of the other colours by any mixture of two of the three colours, while any colour can be matched by a suitable mixture of them." The fact is that this power of producing other colours by mixture of paints is due to their not being simple, but compound colours, as has been already explained.

There is, however, another three-colour theory, which is supported by the names of Young, Maxwell, and Helmholtz, and this is founded not on paints, or indeed on any external

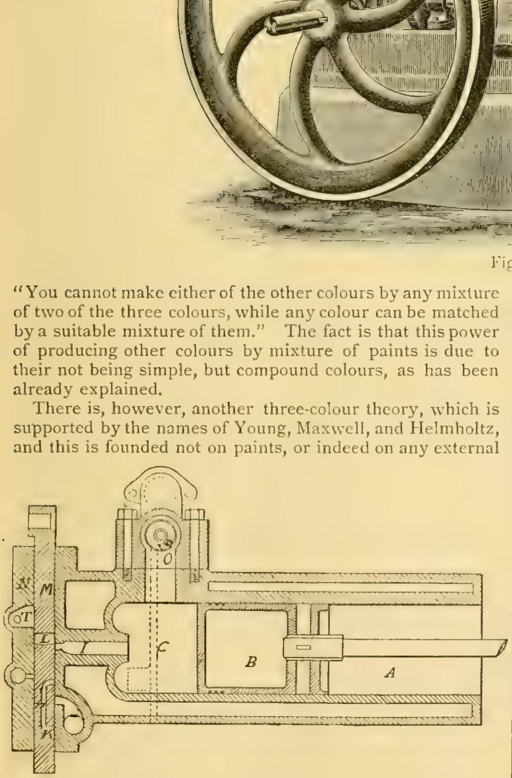


Fig. 5.

colours, but on the structure of the eye. It has been almost indisputably proved that there are three sets of nerves, or three processes of sensation in the eye, for red, green, and blue or violet. The blue may be approximately represented by ultramarine, the red by vermilion, and the green by emerald-green paint, but the two latter are somewhat too light. It is true that these three colours seem ill-suited to make, by their combination, all other colours, but that is because one is accustomed to think of mixtures of paints, not of colours proper. There are many ways, but they are beyond the scope of this article, in which it may be plainly shown that blue and yellow, or green and purple, or red and blue-green make white, as red and green make yellow. The red-seeing nerves take in the orange and yellow, and the green set takes in the yellow and blue, so that a yellow tint is known by its action on both the red and the green set in a proportion depending on the kind of yellow. When all three are equally excited, the effect of white is produced.

If one of these sets of nerves is fatigued by dwelling for some time on nothing but the colour which principally characterises it, it becomes less capable of being stimulated by it, and if all three sets are then given an equal chance, by looking at a white surface, the other two sets of nerves being, so to speak, fresher in the field, have it all their own way, and give the impression of a blue-green. An example of this is well known in the form of a popular advertisement.

Another instance of the fatigue and repose of the different colour-perceptions is to be noticed at night. Artificial light is generally rich in yellow and red rays, and deficient in blue and violet. In fact, after dark the blue-seeing nerves being, as a rule, so little used, the others warp the judgment of the mind and give a false standard of white. The standard is yellowish, but it is not as though we see through yellow glasses. The more the nerves are excited the whiter is the effect. The mind becomes accustomed to treat a full excitement of the red, a partial excitement of the green, and a feeble impression on the violet-seeing nerves, as an equal stimulation of the three, that is, white; and when a more liberal proportion of blue rays is present, the effect appears as an excess of blue. Who has not heard the expressions "blue" and "steely" as applied to the electric light, while its colour is really a pale primrose when compared with the light of day; and the sun itself, which is after all our only ideal of white, is thought by some to be inferior to many stars in the whiteness of its colour.

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The Institution of Civil Engineers.—The number of members, associates, and students of this Institution on the 2nd of January, the sixty-ninth anniversary, was as follows:—Members, 1,556; Associate Members, 2,231; Associates, 488; Honorary Members, 20; and Students, 929. The total was therefore 5,224, representing an increase in the past year at the rate of $5\frac{1}{4}$ per cent., and of more than 100 per cent. since 1875.

## SCIENCE IN BREWING.

IN these days when the names of Pasteur and Huxley are familiar as household words, and the study of the exact changes which take place during fermentation is deemed worthy of our deepest thinkers, it may be interesting to try to realise how far the scientific spirit has permeated the manufacturing mind, and how far the empirical customs of trade are in accordance with the exact laws of science, and consequently promote true economy. The fiscal changes of 1880 have done much to develop the technical knowledge of brewers, because, under the new plan, the finished beer is taxed instead of the raw material from which it is made; unless from want of skill or proper appliances the brewer's produce is below a certain standard, n which case the Government claims the privilege of taxing the raw material. As a consequence, a large number of small brewers who, from want either of capital or knowledge, are unable to compete with their more fortunate opponents, have disappeared altogether, and the Darwinian law of the survival of the fittest leaves only such as can afford to obtain the necessary technical knowledge.

But what is this technical knowledge, and what has it done for the good of the people? Within the remembrance of the present generation all brewing operations were looked upon as secrets, and mysterious recipes were sold, sometimes at fabulous prices, purporting to instruct brewers in the manufacture of any kind of beer.* Now, happily, chemistry teaches the brewer to test the real value of the materials with which he has to work, and with the assistance of the microscope, gives him some knowledge of those changes which take place between the growth of the raw material and the finished beer.

The materials necessary to produce pure beer in the present day are water, malted grain, raw grain or sugar, hops, and yeast. For the first of these (water) the chemist can do much. The sources of the water are first ascertained, and it is then tested for traces of recent sewage contamination, and for the presence of organic matter. It needs no very deep knowledge of chemistry to make an analysis of the solids contained in the water, *i.e.*, to find its mineral constituents and the acids with which they are in combination, and by carrying his practical knowledge one step further, the chemist can, in the absence of serious organic impurity, make the water suit the kind of beer which he wishes to brew.

It has long been known that the London and Dublin waters are good for stout and porter brewing, and that they are soft waters. The water of the Trent valley, on the other hand, is hard, and is suitable for pale ales; but the modern technical brewer finds no difficulty in adding to soft water the salts contained in the Burton water, and making it practically the same. Even in some districts where such objectionable compounds as Glauber's salts are present in the natural water, it is by no means a complicated chemical reaction, which, by the addition of another objectionable compound (calcic chloride), renders them both beneficial. Sodic sulphate and calcic chloride give sodic chloride (common salt) and calcic sulphate; common salt being valuable in brewing, as in cooking, to preserve those albuminoid substances which would impair the keeping qualities of the beer. Calcic sulphate is the principal salt that renders the Burton water valuable, and, according to old theories, inimitable. The permanent hardness caused by calcic sulphate prevents the colouring substances being dissolved, and gives the pale ale now so much preferred. It must be observed, however, that although common salt is a valuable constituent of brewing water, it does not follow that waters containing salt are desirable for brewing purposes; on the contrary, the presence of the potassic and sodic chlorides is sometimes an indication of sewage contamination.

It is perhaps with the second group of materials referred to that the brewer's chemist can do the most good, for he is able to ascertain the value and suitability of his material for the purpose required.

By the legislation of 1880 a brewer may use almost any material from which an alcoholic drink can be prepared; but experience shows that, except for extreme cheapness, the drink produced from germinated barley is preferable to that made from any other material. The analysis of malts thus becomes an important part of the brewer's work. To ascertain the amount of fermentable sugar or maltose, the dextrin, the nitrogenous matters in the form of soluble albuminoids, and the acid in a decoction (prepared as nearly as possible under the same conditions as the mash in the brewery), has become one of the common processes in a brewer's laboratory. Having ascertained his facts and compared them with the facts ascertained and discovered by physical examination (including the old method of throwing corns into water and finding the percentage of sinkers), comparing the deductions drawn from both, the brewer then knows whether his material is worth buying at any price, and whether it is suitable for a highly alcoholic clean beer, the full-drinking beer generally supplied to the publican, or for the dextrinous beer of Germany. The keeping qualities of the beer are also largely dependent on the excellence of the malt used, and in this, more than in any other respect, the brewer profits by modern science, and knows that he need not have recourse to those numerous panaceas advertised in the trade journals, preservatives which promise such wonderful results, and which are as little beneficial to a pure beer as to a pure milk.

The amount of moisture contained in the malt itself is also important to the brewer, and can readily be ascertained by simple experiment.

If, however, malt happens to be dear, or the brewer wishes to produce a very strong wort, or from preference of flavour, or any other cause he chooses to use sugar, the chemist can do much to help him. In the case of cane sugar, chemical analysis will show, by very simple tests, how much pure sugar is contained in the material purchased. Much of the cane sugar of commerce contains a large proportion of invert or fermentable sugar, and it is, therefore, often valuable to the brewer, although it commands but a low price in the market. This recommendation of cheapness does not apply to such theoretically beautiful preparations as the dextrine-maltose of O'Sullivan, or many saccharines now used; but these have their advantage in being uniform, and the brewer who does not constantly analyse and watch his malt, may depend on regularity of quality and colour obtained from many excellent glucoses now sold.

Another legitimate economic substitute for malt is raw grain, and within certain limits the brewer can use the diastase of the malt, not merely to convert the malt itself into a fermentable sugar, but, with its superfluous power, to convert the starch of the raw grain into the same, so that it can be acted upon by the yeast. Whatever the raw grain may be, whether rice or maize, the two grains most easily used for this purpose, the beers prepared from them have hitherto been lacking in the empyreumatic flavour of the malt beers. Beers so flavoured are preferred in England, but the question of there being danger to health in the use of grain, other than malt, is still open to doubt.*

* "Brewing No Mystery." By R. Bannister.

* *Nineteenth Century*, January, 1887, p. 131.

With regard to hops the chemist does not help much; but yeast lends itself more than the other materials to scientific investigation, for it is the microscope which reveals to the brewer what the flavour of his beer may be. The various ferments which Pasteur has classified yield each a different taste, and the brewer knows that by cleanliness and careful cultivation he must develop the *Saccharomyces cerivisiæ*, or pure yeast, otherwise he will introduce into his brewery germs which give him not only sour, but ill-flavoured beers. Moreover, he knows that by supplying the yeast with oxygen or pure air, he stimulates a healthy growth. So thoroughly have some brewers realised this that in one brewery at Burton there are now fitted a series of miniature fermenting rounds, in which the wort is protected from the atmosphere, and supplied with air filtered through cotton wool. In this way experiments are being made on the growth of pure yeast from a single cell. Without attempting elaborate and costly investigations of this kind, the brewer has learned from his microscope and from Dr. Tyndall the need of cleanliness, and of excluding the floating germs which are always ready to start fermentations other than the alcoholic. It is beyond the limits of this paper to enumerate the various microscopic enemies of the brewer, but the different germs producing sour, ropy, lactic, and butyric fermentations are too often present in many old-established breweries.

Having spoken of the materials legitimately used for the production of good beers, it may be well to say something of those adulterants, the very name of which has gone so far to bring beer into disfavour with the medical profession, and to make it give place to the light wines about the preparation of which we know so little. The substitutes for malt, as mentioned above, are harmless, but there have been prepared, in the form of hop substitutes, quassia, chamomile, and even cocculus indicus. These contain, in a small compass, a large amount of bitter principle, and they must, in a very scarce hop year like 1882, recommend themselves to those brewers who are content to accept, without too strict enquiry, what is given them under a pleasing name. But, as Dr. Graham instructs his pupils, the requisite amount of tannin can be obtained in a very cheap form; and by the careful manipulation of hops, in even a scarce season, the requisite bitter can be secured at a price not ruinous to the brewer. It is worth notice that, whereas now there is an outcry against any hop-substitute, in the first year of King Richard III. a petition was presented to the Lord Mayor by the Brewers' Company against the use of hops, and for many years the brewer could not use hops without rendering himself liable to a penalty.*

In these days a more formidable, because more general, cause of complaint arises from the numerous so-called preservatives, which, to say the least, destroy the pleasant flavour of pure beer. They certainly have a fascination for the brewer in hot weather, when sour beer threatens, and he is tempted by a specious remedy; like an invalid, who, weary of the hygienic measures of his physician, is cajoled by the promises of quackery. The majority of these preservatives are sulphites, and give the familiar and objectionable flavour of sulphuretted hydrogen. They are, however, easily detected by smell or taste, and it is for the public to choose between unpleasant flavour and a chance of sour beer. The quantitative analysis of these compounds is extremely simple.

With regard to the analysis of the complete beer, no part of the chemist's work is so unsatisfactory from a practical brewer's point of view. The process of finding the original gravity or strength of the wort before fermentation is simple and generally known, but the Government tables, on which the results are based, although worked out at the expense of much labour, give from 5 to 10 per cent. below the actual strength, varying as the beer is attenuated and alcoholic, or dextrinous and full-drinking.

So very much is, after all, dependent on public taste, that it becomes absurd to say what is a pure beer. If the public prefer sugar, the brewer will supply it, but, as a matter of fact, the beer produced from malt alone is gaining favour, and the brewers who have brewed entirely from malt are the most successful. Notably is this the case with the eminent firm of Guinness and Co., who, since the year 1880, have greatly increased their trade, although the general depression would have led us to expect a different result. It is worth notice that a weaker beer than was formerly liked is now preferred; and that, although the Inland Revenue shows a decrease, it is not because a less quantity of beer is drunk, but because it is of a lighter kind.

* Bickerdyke: "Curiosities of Ale and Beer," p. 78.

## THE LICK TELESCOPE.

FOR a long time past attention has been directed to the promise of the erection in America of a telescope which was to throw into comparative shade all previously constructed instruments. The latest advice from Mount Hamilton is to the effect that, after most careful attentions in packing, the gigantic lenses of this instrument have been received without any apparent injury, and have been placed in specially prepared fire-proof rooms. This great undertaking has sprung from the munificent bequest of Mr. Lick, amounting to 700,000 dollars. The plan of the observatory is very complete, providing a building of 287 feet in length, a transit house, meridian circle, a photo heliograph, a heliostat, and a photographic house. The situation was chosen on account of the climate and the unobstructed view. It is upon one of the highest peaks of the coast ranges of California, some thirteen miles east of San José, its elevation being 4,250 feet above the sea level. The object in selecting such a site was to escape as far as possible minute particles of matter held in suspension by the atmosphere, the movements and magnification of which have so hindered the employment of large powers. The south dome, it is said, will be one of the finest in existence, and will contain the great telescope. The lenses themselves are the largest yet made. According to the contract, the manufacturers, Messrs. Alvan Clark and Sons, of Cambridgeport, had to construct "an achromatic astronomical object-glass of 36 inches clear aperture." The cost was rather more than 50,000 dollars. In addition there is the photographic lens, which will cost some 13,000 dollars, and these large sums, added to the cost of the dome, 56,000 dollars, will convey some idea of the magnitude of the undertaking. Unfortunately, we shall not for some time be able to see any photographic results, owing to an accident which at once reveals the power of scientific observation, and the difficulty of construction. When the immense disc out of which the "photographic corrector" lens was to be constructed was received from Feil's Paris factory during last spring, it was tested by Messrs. Clark by polarised light, and found that, owing to the lack of perfect annealing, it was subject in some internal parts to great inequalities of strain. Messrs. Clark were careful to note this to the maker, and suggested that the disc would probably not bear working. They proceeded, however, at the request and risk of the maker, but unhappily the disc has demonstrated the exactness of their observation by bursting into three pieces on the grinding tool.

INSANE CHINAMEN IN THE UNITED STATES.—Referring to a popular belief that there are no insane people in China, the American *Journal of Insanity* mentions that Dr. Wilkins, of the Asylum for the Insane at Napa, California, has stated that there were about one hundred insane Chinamen in California. He had also been informed by Chinamen that when a man becomes insane in China he is put in confinement and left alone to die. Dr. Wilkins also stated that in his experience the proportion of Chinese who become insane is not so great as that of other nationalities. They eat rice and unstimulating food, and are less liable to be influenced by the excitements, speculations, and similar causes that serve to bring on insanity amongst others.

## ORTHOCHROMATIC PHOTOGRAPHY.

THE ready-prepared sensitive "dry plate" of commerce is a notable production of chemistry. Previous to its introduction, photographers prepared their sensitive films or plates immediately before using them, a process at once costly, unclean, and uncertain. It involved the use of cumbersome apparatus, and the plates when prepared lacked the desired sensitiveness; but all this has been changed by the use of dry plates, as they can be made of any desired sensitiveness, and, generally speaking, are of excellent quality. There is, however, still this one great defect in photography; it represents certain colours in a manner quite opposite to the effect they produce on the visual organs. Being now familiar with the ordinary photographic representations of colour, we do not realise this reversal of tones with the same force, perhaps, as those who in the early days of photography nick-named it the "black art." It is, however, none the less true, that pale yellows, for instance, are represented as though they were dark colours. Blues, on the other hand, appear in comparatively light shades. Dark blue is represented by the ordinary photographic plate as though it were a lighter colour than a lemon; and this under precisely similar conditions of exposure. There is, in fact, a great need of a sensitive plate capable of representing all colours in their true scale of tones. Many attempts have been made to produce such plates. They are generally known as "Orthochromatic," or direct-colour plates.

Mr. W. H. Hyslop recently read a paper on this subject at a Photographic Conference held at the Society of Arts, and he then exhibited some very interesting diagrams, showing the different colour-effects produced by dry plates differently prepared, but exposed to light under precisely similar conditions. Having permission to reproduce these diagrams we have selected the two most typical, and by their aid we trust to make clear the advantage of the orthochromatic system. Fig. 1 is a photograph of bands of different colours taken with an ordinary bromide of silver plate, the natural colours of the various stripes being as follows:—D R, dark red; L R, light red; Bl., black; L, lemon; Or., orange; D B, dark blue; L B, light blue; W, white; Gr., green; Vio., violet.

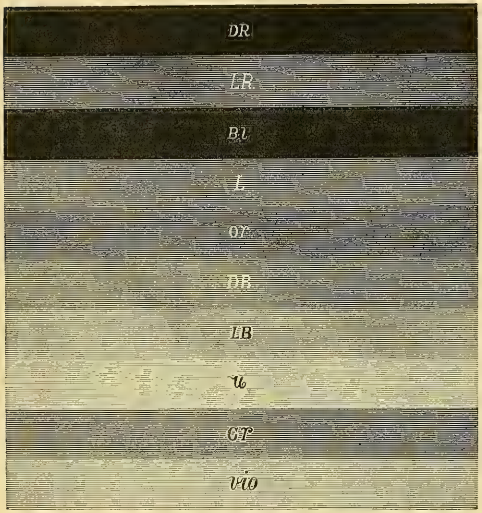


Fig. 1.

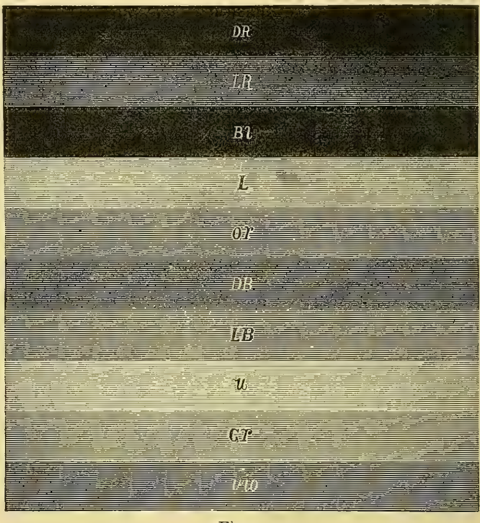


Fig. 2.

It will be seen at once that the effects produced on the photograph are nearly the reverse of those seen in the object photographed. Fig. 2, on the other hand, shows a much nearer approximation to right shades, and has been produced by using an orthochromatic plate, in the preparation of which erythrosine has been introduced, and by placing a faint yellow glass screen between the object and the plate.

It will be noticed that the lemon colour, which appears dark in Fig. 1, is much brighter and more natural in Fig. 2. In the orange band the effect is still more striking. Violet we naturally regard as a moderately dark colour; but photography has hitherto represented it as one of the lightest. To understand the reason of this let us, for a moment, consider the relation to photography of the three great divisions of the spectrum, viz., the chemical, visual, and heat rays. Photography is essentially a chemical process, the chemical and ultra-chemical rays affecting vigorously the sensitive plate. The visual rays have considerably less effect; the heat rays have, comparatively, none. If then we place the object shown in our diagram side by side with the spectrum, we can at once see the cause of the reversal of tones in the photograph. The violet band reflects the chemical rays, and the result is a strong impression upon the plate. Hence a light colour is shown on the finished print. The opposite of this is seen in the case of the reds, and undoubtedly red is to us a very striking colour. Photography, however, requires rays having the necessary chemical properties, and of these red has little or none. Practically no effect is produced when the sensitive plate is exposed to the red rays, and the finished print therefore shows red as a dark colour. Yellow may be shown to have an intermediate effect, but the examples given are sufficient to explain the general principle.

The very important question then presents itself: In what way can the sensitiveness of the photographic plate to the various rays be altered and controlled ?

To a certain extent, a practical answer has been given by the improved effect shown in Fig. 2, and this result has been attained as follows :—A plate has been used in which erythrosine has been introduced in the preparation, and by means of this the blue, or chemical rays, have been checked, whilst the other rays have been made relatively stronger. Further than this, a faint yellow screen is placed between the object and the plate, to intercept a portion of the chemical rays in the manner already referred to.

Unfortunately, there is a great drawback to this process. It is that no means have yet been devised for making the visual and heat rays more chemically active. It is chiefly by intercepting the powerful chemical rays, reflected by the object, that the result is obtained ; but a prolongation of the exposure must, of necessity, be resorted to. For portraiture, this would be very objectionable, as it would make pleasing expressions almost impossible ; and having to be photographed would be voted more of a nuisance than ever. Happily, in many other branches of photographic work, a slightly prolonged exposure is in many cases of no importance, and for copying pictures especially, the orthochromatic plates can alone give an adequate representation of the painter's work. For "still-life," also, these plates can be used with great advantage, and for certain landscapes a decidedly more truthful representation and more pleasing effects would be obtained. The subject is, however, still far from being mastered, but the signs of interest shown in this particular branch of photography bid fair to be productive of very important results.

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Electrical Resistance of Metals at very Low Temperatures.—The term "permanent gases" has ceased to occur in the newer editions of our text-books of science. Carbonic acid was condensed years ago. Hydrogen was liquefied in 1879 by Pictet, and at the same time by Cailletet ; and one after the other of the so-called permanent gases, and even our air, had to yield. The artificial cold produced by the rapid evaporation of one of these gases has been made use of to obtain the condensation of another gas. M. Wroblewski, who has distinguished himself in connection with these experiments, has now tested the electrical resistance of copper when exposed to the greatest cold he could obtain —201° Centigrade (330° Fahrenheit below zero). Spirals of copper wire, covered with silk, were plunged directly into the refrigerating liquids, and it was found that the electrical resistance decreased more rapidly than the temperature. At the temperature mentioned, the electrical resistance was only one-tenth of the resistance of the copper wire at freezing point. MM. Cailletet and Bouty, experimenting with the more moderate cold of 122° Centigrade, fully confirmed this decrease of resistance with decrease of temperature for silver, aluminium, tin, iron, copper, and other metals ; also for mercury, which, when solid, has only one-fourth of its resistance when liquid. It is noteworthy that the formerly so-called permanent gases, hydrogen, nitrogen, oxygen, etc., are electrically insulators when in the liquid state.

Milk Infection.—The official report has now been published of Mr. W. H. Power, Medical Inspector of the Local Government Board, on the disease of cows which occurred in November and December, 1885, at a farm at Hendon, in Middlesex. The case attracted much attention, as it was supposed that the cows originated an infection which produced scarlet fever in those who drank their milk. From the evidence given in this report it seems to be conclusively established that the cow-disease did actually cause scarlet fever in human beings.

A Steam-propelled Torpedo.—Mr. Edward C. Peck, who has charge of the draughting department at Yarrow and Co.'s Torpedo Boat Works, has designed a fish torpedo to be propelled by steam. It is of the usual Admiralty pattern outside, being 14ft. long by 14in. diameter, and it will carry 100lb. of gun-cotton. At about the centre is a hot-water reservoir, 4ft. long and 11½in. internal diameter. This reservoir will be surrounded by a coating of non-conducting material ¾in. thick, and between the outside and this and the skin of the torpedo will be a space of ⅜in. The reservoir is to be charged with about 160lb. of hot water taken from the main boiler of the torpedo boat. The water will be transferred very rapidly at a pressure of about 400lb. per square inch, and there will be means for raising the temperature of the water, if necessary, during its transfer from the boiler of the boat to the reservoir of the torpedo. It is calculated that the torpedo will keep steam for at least an hour after it has been charged. The quantity of water carried will possess sufficient sensible heat to supply the propelling engines with steam of a slowly decreasing pressure during the run of the torpedo. The space between the reservoir and the skin of the torpedo, as also a portion of the space in the body of the torpedo not otherwise occupied, is utilized as a surface condenser. By this means the weight of the torpedo will be precisely the same at the close as at the commencement of the run. The torpedo will be fitted with engines of 60-horse power indicated, and capable of propelling it through the water at a speed of 32 knots an hour. It will be fitted with the usual fins, rudders, and regulating apparatus to insure its travelling at any required depth and in any desired direction. The advantages of a steam-driven torpedo are said to be very considerable. In the first place weight is saved in the torpedo itself, and the pressure being only about one-fourth of that in the Whitehead torpedo using compressed air, there will be no difficulty in keeping all the joints and connections tight. It is also claimed that whereas compressed air will only give a three-quarter minute run, steam will give a run of a minute and three-quarters. The speed with compressed air is 24 knots, and the average range 600 yards, while with steam Mr. Peck reckons on a speed of 32 knots and a range of 1,800 yards.

Wire Nail Machine.—The manufacture of wire nails extends back about thirty years, and these nails, having originally been made most extensively in France, are perhaps best known as French nails. During the past ten or fifteen years the manufacture has been taken up by Germany, Belgium, and England. The high cost of labour in England, however, as compared with that on the Continent, has kept down the manufacture here. The machines used in making these nails are practically the same in all countries, only one nail being made at a time, and the output being from 75 to 250 per minute, according to the size of the nail being produced. The head of the nail is formed by a blow, so that the machine is often laid up for repairs. A wire nail-making machine on a new principle has recently been introduced in this country. It is the invention of Mr. Clinton Lovell, an American mechanic. This machine produces four nails at once, the output being at the rate of from 400 to 1,200 per minute, according to size, with a great saving of labour, power, and space occupied. The machine is said to be positive in its working and automatic in its action, drawing in the wire from the reels, straightening it, feeding it into the machine, cutting off the blanks, and carrying the blanks to the dies, where they are pointed and headed, and thrown out completed. The wire is never released from the first grip to the time the finished nail is ejected. The whole of the operations in the machine are performed by the simple pressure of the various parts, so that jarring blows are avoided. After the ends of the coils of wire are inserted, the machine is automatic in its working.

The Nordenfelt Submarine Boat was again tried last month in the Bosphorus. She made a run completely submerged, the only indication of her movements being a slight disturbance of the surface from the ensign staff, purposely placed so as to enable the committee to watch her course. The boat carried, in addition to the engineers, several Turks. During the trial she remained hermetically closed, the only steam power used being drawn from the reservoir.

Military Balloons.—It has been officially stated, in the House of Commons, that a sum of two thousand pounds is to be included in the Army Estimates, to be devoted to the development of military ballooning.

## THE SCIENCE OF WAR-SHIP DESIGN.

IN the course of a lecture on this subject, recently delivered by Mr. W. H. White, the able Director of Naval Construction, some interesting particulars were given, illustrating the mighty forces brought into play when the monster guns, carried by our most powerful armour-clad vessels, are fired; and the admirable manner in which such forces are held in subjection by the mechanical appliances of the present day. The modern artillerist is fond of speaking of ships as "gun-carriages." This is doubtless a truth, but not all the truth; for though the gun yet remains the principal weapon, the ram and torpedo will be likely to play an important part in future naval engagements. The battle between guns and armour has been going on ever since our naval constructors followed the example of their French *confreres*, and first placed armour-plates on the sides of war-ships. The contest is often spoken of as a duel, but it is one that is not altogether fought on equal terms. The artillerist has gone on increasing the size of his guns, adding weight on weight, both to the weapons themselves and to the charges with which they are loaded; not altogether with unvarying success, as recent mishaps have only too conclusively proved. The naval constructor has had to submit to the conditions thus imposed on him, and has so made possible the exercise of forces which are antagonistic to the success of his side of the question. The public would do well, therefore, when an unusually heavy projectile pierces an exceptionally thick armour-plate, to award the naval architect his due mead of praise for making the carrying of such a gun a possibility. "Every increase in the weight and power of guns," said Mr. White, "adds to the difficulty of the ship-builder; for, in the final result, every strain incidental to carrying and fighting the guns, has to be borne by the structure of the ship." The *Renown*, one of our largest armour-clad vessels now in progress, has a single turret, in which will be placed two 110-ton breech-loading guns, the largest and most powerful ordnance yet mounted in any of her Majesty's ships. The total moving weight of the turret, guns, etc., exceeds 850 tons. "This enormous weight is concentrated on a circle 36 feet in diameter, and has to be rigidly supported. Around the turret base, and protecting the loading appliances, is an armoured redoubt, weighing close on 800 tons, and extending over a length of 60 feet. This also has to be rigidly supported. When these two guns are fired together, the mechanical energy stored up in both projectiles exceeds 120,000 foot tons, an amount of 'work' equivalent to lifting the whole vessel through a height of 12 feet." We do not suppose the Director of Naval Construction intended to say that he has to provide, in the structure of the ship, for an equivalent to lifting her 12 feet out of water; for the energy stored up in the projectiles, and that due to the recoil, are not brought to bear in the same manner, the speed of the projectile being so far greater than that of the movement of the gun. Still it is only by the most skilful disposition of materials that sufficient strength can be obtained to resist these enormous strains, without increasing the displacement beyond practicable limits.

It is well known that Italy possesses the largest, and many competent authorities seem inclined to say the most powerful, war-ships afloat. The *Italia* and her four sister ships have, or will have when completed, a displacement of 13,251 tons. They are to steam eighteen knots an hour, a speed which it is estimated will require the expenditure of eighteen to nineteen thousand horse power. The total weight of barbette, guns, and mountings, carried at a height of thirty feet above water, closely approaches the total weight of the first-class line-of-battle ship of the eighteenth century. Our own *Nile* and *Trafalgar*, which are being hurried forward to completion with all speed at Portsmouth and Pembroke, will displace 11,940 tons, and they will, it is estimated, steam at their fastest sixteen and a half knots an hour, necessitating an expenditure of twelve thousand horse power. These two noble vessels when completed will be the most powerful ships in the Royal Navy; yet, so far, it would seem they do not compare very favourably with the Italian ships: but there is more still to be said on the side of the latter vessels. The *Nile* and *Trafalgar* will both carry four 67-ton breech-loading guns, to serve as their chief weapons of offence, whilst the *Italia* and her consorts will each be armed with four 110-ton breech-loaders. We therefore see that the Italian ships far outstrip our own in size, speed, and weight of armament; but it is needless to say there is something to set off against all this The *Nile* and *Trafalgar* will each have in addition to the armour on the citadel and turrets, and an armoured deck, a belt of steel faced armour on the water line with a maximum thickness of twenty inches. The Italian ships are, on the other hand, entirely without armour on their sides, but the vital parts of these vessels are protected by massive plates wrought inside the vessel. We therefore see that whilst the English ships have twenty inches of steel-faced armour on the water line to keep out the projectiles of the 110-ton Italian guns, the sides of the Italian ships would offer free and unrestricted passage to the projectiles of the English 67-ton guns. The great question of the day is, which of these two is the best system? Both sides have able advocates, and it may safely be said that the problem will never definitely be solved until the "rough arbitrament of war" brings the matter to a practical issue. We may joyfully say that Italy and England have too many bonds of sympathy and affection for it ever to be likely that their fleets will engage in more than friendly rivalry.

A modern war-ship, as has been often pointed out of late, is a compromise. The extension of one element of defence or attack can only be obtained at the expense of others. Thus, an undue weight of armour necessitates smaller guns, lighter propelling machinery, and consequently slower speed, or the lack of some other desirable feature. But after all, the great governing principle on which all others are based is that of cost. The British taxpayer will only submit to be mulcted a certain sum annually, and it must be remembered that war-ships are not only expensive to build but costly to keep up. The question therefore is, which is the best way to spend the money? Some critics of our policy of construction say we ought to put side armour on our ships from stem to stern. "Very good," say the Admiralty constructors, "but if so, we must make the ships bigger and more costly, and therefore there must be fewer ships, or more money must be forthcoming." The *Nile* and *Trafalgar* will cost close on a million apiece, and the money spent on their armour alone would purchase a couple of armoured cruisers complete, with armament on board ready for battle. It is said that a design of a war-ship, prepared at the Admiralty, to embrace all the more important conditions demanded by various critics, showed an estimated cost of £1,800,000!

It is perhaps an open secret that some of the professional officers at Whitehall consider the abandonment of side armour, at any rate, within the range of "practical politics" in the near future; or at least such was the feeling a very short time ago. Sir Nathaniel Barnaby, the recently retired chief of naval construction, has openly expressed his admiration for the Italian ships and his disapproval of the *Nile* and *Trafalgar*. As a matter of fact, the area protected by outside armour has, in British war-ships, grown less and less of late years, until a check was given to this tendency in the two last-named vessels, when we made what is considered by many a retrograde step towards a more unenlightened epoch when armour-plates were carried from stem to stern. The power of modern guns is so enormous, say some, that it is useless to try to keep out projectiles along the whole length of the ship. We cannot protect flotation, or rather stability, by armour. A fighting ship must take her chance in war, trusting to speed, ease in manœuvring, and the skill and courage of her crew and officers. Armour on her sides is, or ought to be, as absolute as armour on the breast of a soldier: both alike doomed by the higher penetrative power of the weapons opposed to them. In the meantime much can be done by armour for the protection of magazines, machinery, and gun positions, "the vitals," as they are termed; and, above all, an armoured deck can be run the whole length of the ship, whilst subdivision by water-tight compartments will do much to minimise the danger from penetration.

Such, roughly, are a few of the elements which underlie the science of war-ship design—problems which we may well hope never to see brought to a practical solution.

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The Welsbach Incandescent Gas Burner.—It will be remembered that at the last meeting of the British Association, Mr. Conrad Cooke described in Section G the system of gas-lighting introduced by Dr. Auer von Welsbach, of Vienna. We understand that several public buildings in Vienna are now lighted satisfactorily by this system, and recently a public exhibition of it on a large scale was made at the Marlborough Gallery in London. We have not seen a photometric test of the lamp, nor a measurement of its gas consumption, but, speaking generally, it appears to us superior to such lamps as Lewis's with platinum gauze, and Clamond's with a cage made from a preparation of magnesia. All are alike in principle, so far as the production of light by means of the incandescence of a refractory substance is concerned; but the Welsbach gauze, or "mantle," as it is called, is more easily raised to a white heat, and therefore requires a smaller consumption of gas. The mantle is formed by dipping a piece of cotton net into a specially-prepared solution containing oxides of zirconium and other bodies; it is then dried, and on being held over a Bunsen flame the cotton is burnt, and there remains a network of the incombustible oxides originally contained in the solution. The mantle is then ready for use, and on being suspended over a special form of atmospheric burner, fitted with a glass chimney, it becomes powerfully incandescent and emits a pleasing white light. Moreover, it is stated that by this system a light equal to 20 standard sperm candles can be produced with a consumption of only $2\frac{1}{2}$ cubic feet of gas per hour. If this is found to be so in practice, and if the mantle is able to stand the rough test of ordinary use, it will doubtless be very largely adopted for shops and houses. We believe it is not recommended for use outside buildings, because it requires a glass chimney and is rather susceptible to air currents; but even this defect may be overcome as the invention is developed.

The Royal Gardens, Kew.—It is proposed to issue from time to time, as an occasional publication, notes, too detailed for the annual report, on economic products and plants to which the attention of the staff of the Royal Gardens has been called in the course of correspondence, or which have been the subject of particular study at Kew. It is hoped that these notes will serve the purpose of an expeditious mode of communication to correspondents in distant parts of the Empire and be of service to the general public. The first number of the "Bulletin of Miscellaneous Information," as the publication is called, has been issued, and contains letters and extracts on teff (eragrostis Abyssinica) and oil of ben.

The International Statistical Institute will hold a meeting in Rome during Easter week.

## THE CONVERSION OF HEAT INTO WORK.

The present century is distinguished by the rapidity with which the application of heat to the service of man has been extended. At the same time, most of the inventors of heat-engines and furnaces have been so ignorant of the principles upon which the action of their inventions depended that lamentable errors have been the consequence. The author of a small book on the "Conversion of Heat into Work"* takes these facts as his text, and produces an instructive and useful work; with only one questionable feature, to which reference will be presently made. The author of this book, Mr. William Anderson, is, however, by no means content to point out past shortcomings; but, step by step, he explains, in a simple and interesting way, the various laws on which the true understanding of the conversion of heat into work depends. The phenomena discussed are familiar to physicists, but for those who have not already studied the subject, a practical handbook of this kind cannot fail to be of use. Some of the questions involved are necessarily difficult, but it is well worth an effort to overcome their intricacies, not only for the practical engineer who seeks to improve the design of a boiler or engine, but for others who should learn to appreciate the great principles involved.

Within the limit of this short notice we are unable to treat in detail the author's statements, but we cannot refrain from pointing out one serious error into which he has fallen. Notwithstanding his own clear exposition of the laws of thermodynamics in the early chapters, in which he shows that the efficiency of a heat-engine depends on the difference between the initial and final temperatures of the working fluid in the cylinder; yet when he describes the actual steam-engine he makes the extraordinary statement, that there is no fall of temperature in the cylinder, and that none of the heat of the steam is converted into work. Moreover, he leads us to suppose that the air in a hot-air engine, and the mixture of gases in a gas-engine, behave in a similar manner. He admits that they all expand, and that in expanding they drive out the piston and do useful work, and yet he infers that they are able to do so without loss of heat. Were this really the case it would be a startling discovery, and would entirely upset the best teaching of the day. It is, indeed, unfortunate that the author should be the first to gainsay the principles so clearly described in the early part of his own book, as in other respects his teaching is at once sound and easy to follow. Possibly, however, the error we have pointed out is merely due to inadvertence or imperfect definition.

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Drilling Holes in Plate Glass.—In a discussion on the above subject, recorded in the last volume of the "Transactions of the American Society of Mechanical Engineers," several methods of drilling holes in plate glass were mentioned. The following appear to be the most successful:—1. Holes $\frac{3}{16}''$, in diameter in plate glass $\frac{1}{8}''$ thick, can be made with an ordinary bow drill, spirits of turpentine being used as a lubricant. The hole should be drilled from one side until the drill has just perforated the glass; the glass should then be reversed and drilled from the other side. 2. Holes $\frac{7}{16}''$ in diameter in glass $\frac{1}{8}''$ thick can be made with a brass tube drill, with fine emery as the cutting agent. The drill is run at a speed of 2,000 revolutions to the minute, with water as a lubricant. The drilling of forty such holes uses up about one inch of the tube. The well-known sand blast was also referred to, but this is only suitable for work on a large scale.

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* *On the Conversion of Heat into Work; a Practical Handbook on Heat Engines.* By Wm. Anderson, M.Inst.C.E. London: Whittaker and Co., and George Bell and Sons, 1887. Price 6s.

## THE CANAL THROUGH THE ISTHMUS OF CORINTH.

THIS year will, it is said, see the completion of the canal through the Isthmus of Corinth. It is an ancient engineering project that has lingered for ages, awaiting the development of those mechanical and chemical sciences, which have been the great characteristic of the present century. It may indeed be called an ancient project, since it is connected with the name of one of the seven sages, Penander, who flourished 628 B.C. Penander, however, was not able to overcome the superstitious opposition of the priests. Demetrios Poliorpetes, King of Macedonia, about 300 B.C., also entertained the project of piercing the isthmus, but failed to carry out his intention, because his scientific advisers, anticipating the fallacy which arose when the Suez Canal scheme bid fair to become realised, asserted that the difference in the levels of the sea would offer an unsurmountable obstacle. Yet we find the Emperor Nero, with all pomp and magnificence, actually commencing operations himself with a golden spade. Thousands of slaves were employed, among whom were 6,000 Jews; presumably with less costly tools. Nero's engineers must have been able men; some boreholes have been preserved to our days; and the Société Internationale du Canal Maritime de Corinthe has adhered to the line which these boreholes mark. The final success of the scheme seems mainly due to the exertions of an old Hungarian soldier of revolutionary fame, Stefan Türr, who now lives with his wife, a granddaughter of Lucien Bonaparte, at Isthmia, a place founded by himself. The canal will extend from Isthmia to Posidonia. It will be four miles long, and shorten the passage from Venice, Trieste, Brindisi, etc., to the Black Sea, by about two hundred miles; and from Marseilles, and other Mediterranean ports, by about half that distance. The passage will, further, be much safer, the dangerous promontories of the Greek Peloponnesus being avoided. Operations commenced on the 8th of April, 1882. Eleven million cubic yards have to be removed. In some places the hills rise to 240 ft., and geologists will find a rich field when the territory becomes more accessible to them. It is clear that Poseidon has not in vain ruled there for centuries, for those rocks through which the cutting has been made have experienced rougher concussions than from dynamite and powder, which are at work now. The cutting is made with high perpendicular walls; the miner—generally an Italian or a Montenegrin—stands on a ridge scarcely more than a hand wide, having a rope attached to an iron bracket above fastened round his body, and works the ground away from underneath his feet. The subjects of the two nations mentioned have taken the main share in the rougher and more dangerous work. Armenians are generally employed for the earth work; Greeks are hardly seen, unless in the offices, as doctors in the hospitals, or in some other of the more sedentary pursuits. The dimensions of the canal are exactly those of the Suez Canal, 72 ft. in width, 26 ft. in depth, below the deepest water level. The railway from Athens to Corinth crosses by a bridge at the highest point, 300 ft. above the water. The costs of maintenance are expected to be small, since there is no danger from sand, nor from rapid erosion of the vertical walls, which mainly consist of hard rocks. The company has risked thirty-five million francs (£1,400,000), and intends to levy a toll of one franc per ton for vessels from the Adriatic Sea and half that sum for other ships; each passenger to pay one franc. Mr. Eduard Engel has recently visited the works, and we are indebted to his interesting pamphlet, "Griechische Fruehlings-Tage," just published, for these particulars. The rapid strides which the Greek mercantile marine has made in the last years, promise well for the future of the canal; at the end of 1885, the Greek mercantile marine ranked already eleventh, with 3,215 vessels, among which were 72 steamers.

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THE PRESENCE OF DISSOLVED SALTS IN VAPOURS.—That some liquid particles are mechanically carried away from a liquid when violently boiling, is evident. That a certain quantity of solid substances in solution (such solids as are not supposed to be volatile) will evaporate with the liquid at all temperatures, has also been demonstrated by M. Marguerite Delacharlonny. He experimented with solutions of sulphuric acid, caustic soda, and sulphate of iron. Laboratory tests showed the presence of these bodies in the vapours given off after two and three days. Experiments were then arranged on a larger scale, with sulphate of iron and alum. Test papers impregnated with litmus and helianthin were suspended above, and after two or three days the papers turned colour, the colour being uniform, not spotted, as would be the case from any solid particles accidentally carried over. The observations may be interpreted in a two-fold way. Many bodies, not generally regarded as volatile, are so to a very slight extent. Copper may belong to these, as its smell would indicate. Others not volatile in themselves become so when dissolved in and together with certain liquids, and use is made of this peculiarity for separating certain bodies from one another.

SACCHARIN.—The method now published for manufacturing the new sweetening agent saccharin, or anhydroortho-sulfaminbenzoïc acid, the invention of Dr. Constantin Fahlberg, of New York, will hardly tend to increase the fears of the ordinary sugar manufacturer. The inventor starts with toluene, one of the many constituents of coal oils; treats it with concentrated sulphuric acid, converts the sulphonic acids obtained into the calcium, then into the sodium salts; mixes the dry sodium salts with trichloride of phosphorus and passes chlorine gas over the mixture. The next step is to remove by distillation the resulting phosphorus oxychloride, and separate the two sulpho-chlorides by centrifugation, the para product crystallising whilst the ortho-product remains liquid. The latter is transformed into a sulphamide by means of dry ammonia gas or carbonate of ammonia, purified by washing with water and oxidised in a solution of permanganate of potash. This latter operation requires great care; the potash salt so obtained has then only to be decomposed to yield the free acid, the saccharin, in white crystals, soluble with difficulty in cold water, but easily in hot water. The process looks somewhat complicated; and as sugar is now so cheap, saccharin does not appear to be a very formidable rival, even if its pleasant sweet taste is perceptible in solutions of one in 10,000 parts of water, and if A. Stutzer is right in asserting that the continued use of saccharin is not accompanied by any injurious effects.

POLARISATION OF RESISTANCE COILS.—Last autumn, at the Buffalo meeting of the American Association of Science, Professor Mendenhall drew attention to a peculiar polarisation, of which all his resistance coils seemed to suffer, and which he believed to be of statical nature. Professor Benjamin Thomas then examined his coils at Columbus, Ohio, with the help of a Thomson astatic galvanometer made by Elliott Brothers. With the exception of one B A coil, made by the same firm, they all gave a polarisation deflection; and it was noticed that the wire terminal, which was positive during charge, was again positive during discharge. The polarisation effect was further a steady, though of course faint, current, remaining observable in one instance for ten hours. An experimental coil of 1,800 ohms simply wound with cotton on a rainy day proved worse than all others examined, but exhibited no trace of polarisation after having been baked at 150° C (300° Fahrenheit), or again after having been paraffined. Ten days afterwards, however, the polarisation reappeared; and a drop of water put on the coil increased it to its former maximum within five minutes. The polarisation appears thus to be due to the electrolysis of the moisture absorbed from the atmosphere. For very accurate resistance coils, the ordinary paraffin insulation would not be safe; and Mr. Thomas recommends either to fill the space about the coil entirely with paraffin, or to employ impervious boxes filled with a suitable petroleum.

Higher Explosives for Artillery.—The enormous power of the higher explosives, of which dynamite is the best known, has ever been looked on with longing eyes by that ingenious and very numerous class of persons who devise new methods of human destruction. Up to recent times, however, higher explosives have proved a very *ignis fatuus* to the military inventor, but within the last few weeks, some substantial progress is reported to have been made in the United States. The Government authorities of that country have established a Dynamite Board, and the arguments brought forward by this body have convinced Mr. Whitney, the secretary of the U.S. navy, that there is a fair chance of a higher explosive than gunpowder being used for the bursting charges of shells in large guns, or rather long guns, for we believe some of the weapons proposed are 120 to 168 calibres long. As is pretty well known, the reason that the higher explosives have not been used in shells, is on account of their liability to explode in the gun by the concussion of the discharge. Much ingenuity has been expended in the effort to set the projectile in motion more gradually. One weapon was made, or proposed, with pockets at the side to be filled with powder which would explode as the projectile passed it. Another inventor devised a buffer arrangement of india-rubber, metal springs have been suggested, whilst the devices are legion in which air has been proposed as a cushion. An air-gun appears, however, to be the favoured device of the Dynamite Board. The projectile of this weapon, which has a 12½ in. bore, is to contain 400 lbs. of nitro-gelatine. Three of these guns, it is said, are to be mounted on one of the new cruisers now being constructed for the U.S. navy. The Americans say that the nitro-glycerine is twenty times more destructive than the most powerful explosive that we in Europe have experimented with, for the 200 lb. charge, which was that originally proposed, is equal to about 2,000 lbs. of gun cotton. As for the destruction that would be wrought by the larger charge of 400 lbs., that, they say, is beyond computation, but it is enough for us to know that it would "level an army to the ground, and kill or demoralise every sailor in a fleet." In which case, it would appear, that the millennium has at last arrived

A Russian Volcano.—Not long ago the town of Baku, in Southern Russia, was threatened with partial destruction by the sudden outburst of a natural naphtha fountain. Now a volcano of earth and hot mud has broken out about ten miles from the town on the Lok Batan. The following is taken from a *Times* telegram:—"Quite suddenly, at eleven o'clock at night, the noise of an explosion was heard, and from the summit of Lok Botan there was shot up an enormous column of fire some 350 feet high. The whole country was instantly lit up brighter than day, and the heat could be felt at nearly a mile from the crater. There was scarcely any wind, so that the column continued to ascend quite vertically. This lasted with short intervals of subsidence all through the night, and the following twenty-four hours. The volume of muddy liquid thrown out was estimated at half a million cubic *sojenes*—the Russian *sojene* equalling seven feet—and has spread itself over more than a square mile to a depth of from seven to fourteen feet."

## THE ROYAL INSTITUTION.

Sir William Thomson delivered a lecture, on the 21st of January last, at the Royal Institution. The subject was the probable origin, the total amount, and the possible duration of the sun's heat. The natural history of plants and animals within the time of human history showed that there had been no exceedingly great change in the intensity of the sun's heat and light during the last 3,000 years; but there might have been changes of 5 or 6 per cent. But we had proof of something vastly more than 3,000 years in geological history for the mere age of the sun, and evidence of continuity of life on the earth probably for millions of years past. The sun had been doing work at the rate of 476,000 millions of millions of millions horse-power, and at possibly more than that rate, for a few million years. The explanation of this, which possessed the highest probability, was Helmholtz's form of the meteoric theory, the principle of which was that the sun's initial heat was generated by the collision of masses gravitationally attracted to one another from distant space to build up its present mass; and the shrinkage due to cooling gave, through the work done by the mutual gravitation of all parts of the shrinking mass, the vast thermal capacity, in virtue of which the cooling had been and was so slow. The rate of shrinkage corresponding to the present rate of solar radiation was 33⅓ metres on the radius per year, or one ten-thousandth of its own length on the radius per 2,000 years. Hence, if the solar radiation had been about the same as at present for 200,000 years, the sun's radius must have been greater by 1 per cent. 200,000 years ago than now. If the sun's effective thermal capacity could be maintained by shrinkage till twenty million times the present year's amount of heat was radiated away, the sun's radius would be half what it is now. But the density which this would imply, being more than eleven times that of water, was probably too great to allow the free shrinkage to be still continued without obstruction through overcrowding of the molecules. It seemed, therefore, most probable that we could not, for the future, reckon on more of solar radiation than twenty million times the amount at present radiated out in a year. Also the greatly diminished radiating surface at a much lower temperature would give out annually much less heat than the sun in its present condition. These considerations had led Newcomb to the conclusion that it was hardly likely that the sun could continue to give sufficient heat to support life on the earth—such life as we were acquainted with, at least—for ten millions of years from now. In these calculations the density of the sun had been considered as uniform for the sake of simplicity. In reality, there must be a wide difference between the density at the centre of the sun and the density at the surface; but it did not seem probable that the correction could add more than a few million years to the past of solar heat, and what could be added to the past would have to be deducted from the future. By the light of more recent calculation, and taking into account all possibilities of greater density in the sun's interior and of greater and less activity of radiation in past ages, it would be rash to assume as probable anything more than twenty million years of the sun's light in the past history of the earth, or to reckon on more than five or six million years of sunlight for the future. As to the early history of the sun, five or ten million years ago it might have been about double its present diameter and an eighth of its present mean density, but we could not with any probability of argument go on continuously much beyond that time. It was impossible to help asking, however, What was the condition of the sun's matter before it came together and became hot? It might have been two cool solid masses which came into collision with the velocity due to mutual gravitation, or, but with enormously less of probability, it might have been two masses coming into collision with velocities considerably greater than those due to gravitation. If two cool solid globes, each of the same mean density as the earth and of half the sun's diameter, were given at rest at a distance asunder equal to twice the earth's distance from the sun, they would fall together in half a year. The collision would last a few hours, and in the course of it the globes would be transformed into a violently agitated incandescent fluid mass, with about eighteen million years' heat ready made in it, and swelled out to possibly three or four times the sun's present diameter. If, instead of being initially at rest, two globes had a transverse relative velocity of 1·42 kilomètres a second, they would just escape a collision, and would revolve in equal ellipses round the centre of inertia. If the initial transverse relative velocity were a little less than 1·42 kilomètres a second, there would be a violent grazing collision, and two bright suns would come into existence in a few hours and commence revolving round their common centre of inertia in long elliptic orbits, the eccentricity of which would be diminished. If the initial transverse component relative velocity of the two bodies were just 68 mètres, the moment of momentum would be just equal to that of the solar system, of which 17-18ths was Jupiter's and 1-18th the sun's, the other bodies of the system not being worth considering in the account. Assuming the sun's mass to be composed of portions which were far asunder before the sun was hot, the immediate antecedent to its incandescence must have been either two bodies with details differing only in proportion and densities from the cases considered; or it must have been some number more than two—at the most the number of atoms in the sun's present mass. The immediate antecedent to incandescence might have been the whole portions in the extreme condition of subdivision; or it might have been any smaller number of groups of atoms making up minute crystals; or it might have been lumps of matter like meteoric stones. For the theory of the sun it was indifferent which of these alternatives was accepted; but we could not but adopt the common opinion which regarded meteorites as fragments broken from larger masses, and we could not be satisfied without trying to imagine what were the antecedents of those masses. Nothing short of atoms seemed admissible as a theory of the primitive condition of things; and it was strange how we were brought back to the theory of Lucretius.

## THE ROYAL MICROSCOPICAL SOCIETY.

THE Rev. Dr. Dallinger, F.R.S., president of the Royal Microscopical Society was last month re-elected for a fourth year. The annual address which he gave treated mainly on two subjects, the first being as to the value of the new optical glass, introduced by Professor Abbe and Dr. Schott, of Jena. This does away with the secondary spectrum of the microscope, the new lenses being designated "apochromatic." Dr. Dallinger says that a distinct advance has been made in the optics of the microscope, especially in compensating eye-pieces. The second subject of the address was a series of experiments which Dr. Dallinger has conducted for nearly ten years continuously, regarding the extent of change of temperature to which the lower forms of organisms can be adapted by slow modifications. For a year and a half Dr. Dallinger carried on tentative experiments to determine what methods would be most suitable for his purpose: and for nearly seven years continuous experiments and observations were being made with the result that several organisms had gradually become adapted to live and thrive under a temperature approaching that of boiling. Unfortunately an unforeseen accident during Dr. Dallinger's absence terminated the research; but he has again during the past year started from his original point of commencement, with all the improvements suggested by experience. The great object was to keep several species of the minute monads, without intermission, under a constant temperature, with the power of increasing the temperature by one degree or less at a time. This was done by a complex apparatus based on Professor Schäfer's ingenious device for maintaining a constant temperature in a warm stage for the microscope. The apparatus was kept in a room at a constant temperature, and was supplied with gas at an unchanging pressure. The variation of the thermostats now at work is less than one-sixth of a degree Fahrenheit in 24 hours. The water in which the organisms lived was kept in constant communication with the microscope stage, and they could be examined alive at the temperature at which they were being cultivated. Commencing at the normal temperature of 60° F., the first four months were occupied in raising the temperature 10° without altering the life-history. When the temperature of 73° was reached, an adverse influence appeared to be exerted on the vitality and productiveness of the organisms. The heat being left constant for two months, they regained their full vigour, and, by very gradual stages of increase, 78° was reached in five months more. Again a long pause was necessary, and during the period of adaptation a marked development of vacuoles was noticed, which again disappeared when it was possible to raise the temperature further. The further history of the experiments presented practically the same features—long pauses, vacuolation, slow advance —until at last the high temperature of 158° F. was reached, when the research was accidentally terminated. It is because it is so difficult to observe the effects of changes through a sufficient number of generations of larger animals that results obtained on the simpler forms are so valuable. Darwin distinctly insisted on the slowness of the process of adaptation; here we have creatures which are incessantly multiplying by dividing, the longest interval being four minutes. Dr. Dallinger must, therefore, have observed something like half a million generations of the organisms under consideration. Here are the "countless generations" required; and at the end of the series the organisms are found to be fully adapted to a change in the essential condition of life, sufficient to produce death originally.

THE LONDON INSTITUTION.—Professor Meymott Tidy, in a lecture on Chemical Action, given before the London Institution, on the 20th January, described the alteration in the density of bodies resulting from chemical combination. The next alteration of matter referred to as the effects of the chemical forces were changes in the forms of matter, it being shown experimentally that every possible alteration might occur, solids becoming liquids and gases, liquids becoming solids and gases, and gases becoming liquids and solids. Dr. Tidy passed on to consider the various heat-changes produced when substances were combined. Every chemical act, he explained, was accompanied by development or absorption. The heat absorbed by decomposing a substance into its original constituents was equivalent to the heat developed in combining them. Certain difficulties, it was, however, noted, occurred in making heat the exact measure of the chemical act. One of these difficulties was the alteration of state so frequently occurring when chemical action came into play.

# RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.*

*** *The whole of the papers of the Societies referred to are not included in this list.*

## THE ROYAL SOCIETY OF LONDON.

Jan. 6th.—Papers read, (1) "On the Occurrence of Silver in Volcanic Ash from the Eruption of Cotopaxi," by Dr. J. W. Mallet; (2) "On the Continuity of the Liquid and Gaseous State of Matter," by Prof. Ramsay and Dr. Goring.

Jan. 13th.—Papers read, (1) "Supplementary Note on the Values of the Napierian Logarithms of 2, 3, 5, 7, 10, and of the Modulus of Common Logarithms," by Prof. J. C. Adams; (2) "On the Crimson Line of the Phosphorescent Alumina," by Mr. W. Crookes.

Jan. 27th.—Papers read, (1) "On a Perspective Microscope," by Mr. G. J. Birch; (2) "On the Thermodynamic Properties of Substances whose Intrinsic Equation is a Linear Function of the Pressure and Temperature," by Prof. G. T. Fitz-Gerald, F.R.S.

Feb. 3rd.—Papers read, (1) "On the Waves Produced by a Single Impulse in Water of any Depth, or in a Dispersive Medium"; (2) "On the Formation of a Vortex or Vortices by the Motion of a Solid through an Inviscid Incompressible Fluid," by Sir William Thomson, F.R.S.

Feb. 10th.—Paper read, "Contributions to the Metallurgy of Bismuth," by Mr. Edw. Matthey.

Feb. 24.—Papers read, (1) "Problems in Mechanism regarding Trains of Pulleys and Drums of Least Weight for a given Velocity Ratio," by Prof. Hennessy, F.R.S.; (2) "On the Relation between Tropical and Extra-Tropical Cyclones," by the Hon. R. Abercromby; (3) "A Thermal Telephone Transmitter," by Prof. G. Forbes.

Feb. 17.—Papers read, (1) "A Record of Experiments upon the Functions of the Cerebral Cortex," by Prof. Schafer, F.R.S., and Prof. Horsley, F.R.S.; (2) "On Radiant Matter Spectroscopy: Examination of the Residual Glow," by W. Crookes, F.R.S.

## ROYAL SOCIETY OF EDINBURGH.

Jan. 7th.—Special Afternoon Meeting. Address, "On Processes of Refrigeration," by Mr. J. J. Coleman, of Glasgow.

## THE SOCIETY OF ARTS.

Jan. 24th.—Cantor Lecture, "On the Diseases of Plants, with Special Regard to Agriculture and Forestry," by Dr. Thudichum.

Jan. 25th.—Paper read, "On Volcanic Eruption in New Zealand," by Mr. K. Nicholls.

Jan. 26th.—Paper read, "On Photographic Lenses," by Mr. J. T. Taylor.

Feb. 11th.—Paper read, "On the Economical Condition of India," by Dr. G. Watt.

Feb. 14th.—Cantor Lecture, "On Building Materials," by Mr. W. Y. Dent.

Feb. 15th.—Ordinary Meeting. Paper read, "On Colonial Woods," by Mr. A. Ransome.

Feb. 16th.—Paper read, "On Uses, Objects, and Methods of Technical Education in Elementary Schools," by Mr. H. H. Cunynghame.

## THE INSTITUTION OF CIVIL ENGINEERS.

Jan. 25th.—Ordinary Meeting. Papers read, (1) "On Sewage Sludge and its Disposal," by Mr. William Dibdin, F.C.S., F.I.C.; (2) "On Filter Presses for the Treatment of Sewage Sludge," by Mr. W. S. Crimp, Assoc. M. Inst. C.E., F.G.S.

STUDENTS' MEETINGS.

Jan. 21st.—Paper read, "On the Use of Cast-Steel in Locomotive Construction," by Mr. A. J. Hill.

Jan 27th.—Birmingham Association of Students. Meeting at Birmingham. Paper read, "On the Kidderminster Sewerage and Water Supply," by Mr. R. Pierce, Stud. Inst. C.E.

Feb. 4th.—Paper read, "On Recent Researches in Friction," by Mr. J. Goodman.

Feb. 17th.—Glasgow Association of Students. Meeting at Glasgow. Lecture, "On the Early History of Railways," by Mr. C. P. Hogg, M. Inst. C.E.

Feb. 18th.—Paper read, "Diving: The Apparatus Used, and the Work Carried out under Water," by Mr. G. Becks.

## THE INSTITUTION OF MECHANICAL ENGINEERS.

Feb. 3rd and 4th.—Fortieth Annual General Meeting. "Inaugural Address," by the President, Mr. E. H. Carbutt. Conclusion of adjourned discussion on the late Mr. Robert Wyllie's paper,

* In order to make this record complete for the year, so far as it goes, it is carried back to the beginning of January, but the pressure the additional matter thus dealt with puts on our space, compels us to leave some of the notices over until next month.

"On the Triple Expansion Marine Engine." Papers read and discussed, (1) "Description of a Portable Hydraulic Drilling Machine," by M. Marc Berrier-Fontaine, of Toulon; (2) "On Copper Mining in the Lake Superior District," by Mr. Edgar P. Rathbone; (3) "Notes on the Pumping Engines at the Lincoln Water Works," by Mr. Henry Teague. The Council have appointed a Research Committee to inquire into the question of Steam Jacketing of Engines, Mr. Henry Davey, of Leeds, to conduct the experiments. The summer meeting will be held at Edinburgh in August.

### SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

Jan. 13th.—Winter Session opened. "Inaugural Address" of the President, Sir Charles Bright.

Jan. 27th.—Paper read, "On Telephonic Investigations," by Prof. Sylvanus P. Thompson.

### PHYSICAL SOCIETY.

Jan. 22nd.—Papers read, (1) "The Permanent and Temporary Effects on Some of the Physical Properties of Iron Produced by Raising the Temperature to 100 deg. Cent.," by Mr. Herbert Tomlinson, B.A.; (2) "On Some New Measuring Instruments used in Testing Materials," by Prof. W. C. Unwin, F.R.S.

Feb. 12th.—Annual General Meeting. Paper read and discussed, "Note on the Tenacity of Spun Glass," by Messrs. E. Gibson and R. E. Gregory.

### SOCIETY OF ENGINEERS.

Feb. 7th.—"Inaugural Address," by the President, Prof. Henry Robinson.

### THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS OF SCOTLAND.

Jan. 27th.—Ordinary Meeting. Paper read, "On the Shafting of Screw Steamers," by Mr. Hector McColl, of Liverpool.

### ROYAL METEOROLOGICAL SOCIETY.

Jan. 19th.—Monthly Meeting. Papers read, (1) "On the Identity of Cloud Forms all over the World," by the Hon. R. Abercromby, F.R. Met. Soc.; (2) "On the Cloud to which the Name 'Roll-Cumulus' has been applied," by the same Author.

Jan. 19th.—Annual General Meeting. The President, Mr. W. Ellis, delivered his address.

### KING'S COLLEGE ENGINEERING SOCIETY.

Jan. 18th.—General Meeting. The President, Mr. C. J. Vesey Brown, delivered his "Inaugural Address."

### JUNIOR ENGINEERING SOCIETY.

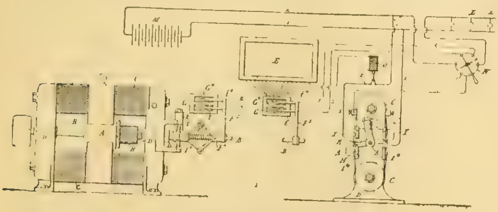
Jan. 21.—Introductory Address, "On the Relation of Chemistry to Engineering," by Prof. H. E. Armstrong, Vice-President.

Feb. 19th.—Excursion. Visit the University College Engineering Laboratory, by invitation of the President, Prof. A. B. W. Kennedy.

## RECENT PATENTS PUBLISHED.

*The following list of abridgments has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No. 12,372. Louis John Crossley, of Halifax, in the County of York, Engineer, and Walter Thomas Goolden and Alexander Pelham Trotter, both of Victoria Chambers, Westminster, electrical engineers. "Improved means for regulating the action of dynamo-electric machines." 16th October, 1885.



This invention relates to improvements in the means and apparatus employed for driving dynamos from sources of power whose motions are irregular, and are occasionally reversed, and is especially applicable to the illumination of trains, etc, where the dynamo is driven from the axle of the carriage or the shaft of the engine.

The dynamo-electric machine is so arranged as to secure its efficiency at a certain minimum speed, and it is provided with a governor which, as the rotation of the machine increases, will throw gradually increased resistance into the shunt circuit, thereby preventing the undue increase of electro-motive force of the machine.

The secondary batteries being connected with the main circuit, will receive any surplus current which is not required by the lamps in the circuit, and will give out that current to the lamps when the speed of the dynamo machine falls below a given point.

The figure shown is a side elevation of a dynamo-electrical machine of the "gramme" type, arranged according to this invention.

*A* is the armature mounted on the axle *B*; *C C* are field magnets secured to the standards *D*; and *E* is the resistance box of any approved construction for putting a regulated resistance into the shunt circuit.

The armature axle *B* is prolonged to form the spindle for a centrifugal governor *F*, which serves to operate a sleeve $F^1$, working over a feather on this spindle, and carrying an arm $F^2$. To the extremity of this arm are secured two insulated elastic fingers $f f^*$, which are designed to travel respectively over a series of contact plates $G G^1$, coupled to the coils of the resistance box.

*H* is the commutator; $I I^*$ are two pairs of insulated metal blocks fixed on one of the end standards *D*, and so situated with regard to each other, and to the axle of the armature, that a bar *K* mounted loosely on the axle may be free to oscillate between them, so as to bring within the same circuit the block *I* at the right side, with the block $I^*$ on the left hand side.

The blocks *II* are connected together by means of a wire, and also to one of the collecting brushes of the commutator, and the blocks $I^* I^*$ are similarly connected together and to the other collecting brush.

The coupling *K*, although free to rock upon its axle, is held tightly thereto by spring pressure, which readily yields to allow of the axle turning freely while the bar is quiescent in one or other of its two positions.

Attached to the opposite ends of this bar are the terminals of the main line wire, which terminals, when in contact with one or other pair of blocks $I I^*$, complete the circuit.

The insulated fingers $f f^*$ are each connected with the shunt wires through the switch *N*: and the coils of the resistance box, which are each connected with their respective plates $G G^*$, are also connected with the shunt wire.

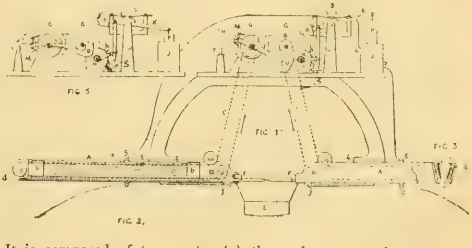
When the fingers $f f^*$ are at their starting points the resistance box will be practically outside the shunt circuit, but as, through the increase of speed of rotation of the machine, the sleeve $F^1$ is traversed by the centrifugal governor *F*, those fingers will be advanced in succession over the plates of the series $G G^*$, bringing at each advance an additional resistance coil within the shunt circuit.

When the switch has cut out the lamps from the main circuit, leaving the electric current from the machine to accumulate in the battery, the high resistance coils are cut out from the shunt circuit, and the low resistance coils thrown in. At this time the finger *f* completes the shunt circuit, the low resistance being thereby brought into the shunt circuit. This provides for the increase of the energy of the field magnets.

When, however, the switch is moved, the lamps are thrown into the main circuit, the finger $f^*$ in this case completing the shunt circuit through the high resistance coils, and thereby modifying the current to the lamps.

No. 450. A communication from André Million, of Lyons. "Improvements in electric lamps." 11th January, 1886.

This lamp is based upon the employment of carbons of small diameter enclosed in reservoirs, whence they emerge successively and automatically to give the light.



It is composed of two parts—(1) the carbon reservoirs; (2) the regulating apparatus.

The carbon reservoirs are composed of two horizontal chambers *A A*, the section of which is that of a trough with inclined sides, the carbon rods, or sticks $a\,a^1$ of uniform length, being arranged along the length of the sides, where they are held by a double wall $b\,b^1$.

At the bottom of the chamber, between the two piles of carbon, passes an endless chain *C C*, furnished with catches *e e*, placed alternately on the right or left at the level of the lower sticks of each pile. This chain passes over the pinion *D*, in front of the chamber over the return guide pulleys *d d*, and the pinions *B B*, operated simultaneously by two toothed wheels *G G*.

The chain advancing in the direction of the arrow, its catches come in contact alternately with the lower carbon, and push it in front into contact with the corresponding carbon of the other chamber; the arc is therefore produced alternately at the point of contact of the carbons on the right or on the left, at $x$ or $x^1$.

The distance of the catches is regulated so that two new carbons arrive in contact at the same time, when those of the opposite side, having gone beyond their supports, fall of themselves in front into the box *E*; the light thus passes without interruption from one pair of carbons to the other.

When the carbons pushed by one of the catches *e* have travelled beyond the roller *D*, they are pressed against the same by a spring roller *f*, placed below, and a little in advance. The current is conducted to the carbons by small metallic contacts *F F*, the carbons being themselves made conductors, and by an electro-deposited coat of copper.

Referring to the regulating apparatus, one of the wheels *G* is driven by a pinion *H*, the axis of which carries a ratchet wheel *I*, put into motion of a click or driver *h*, suspended from a rocking lever *K*, carrying at its other end a piece of soft iron *P*, which enters the bobbin *J*, a retaining click *g* prevents any return motion, when it is not held by the mechanism.

Upon one of the shafts of pinions *B* is mounted a pulley *L*, carrying a break *M*, the pressure of which is obtained by a counterpoise *N*; this break is itself carried by a counterpoised lever *O*, the action of which tends to cause the mechanism to return in its motion, which cannot take place unless the click *g* is raised.

The rocking lever *K* carries a counterpoise *R*, which can raise the cylinder *P*, when no electric action acts upon it. It also carries a distributor *S*, which interrupts or re-establishes the current in the bobbin *J*.

The principal current enters at 1 into the carbon reservoir, and leaves at 2 after having produced the arc between the two carbons. The reservoirs thus acting as conductors are insulated from their supports at 3 and 4. The motor is operated by a derived current 5, 6, 7, and 8, which traverses the bobbin *J*, and which is interrupted at *i i* by the distributor.

This latter establishes or interrupts the current by a small platinum contact *S*, which is displaced with the rocking lever *K*.

The current being established the bobbin will powerfully attract the cylinder, and lowering the rocking lever will displace the distributor; the current will be interrupted and the counterpoise *R* again fall, but before it is able to raise the retaining click *g*, the contact S has re-established the current, and so on.

During this time the lever *N O* carried by the break *M* comes to rest on the stop *T*, and the wheel *L* continues to turn in the interior of the break. At this moment the counterpoise *O* tends to cause the mechanism to return in its motion, but is prevented from doing so by the retaining click *g*, which is no longer raised by the fall of the weight *R*, the motion of which is not sufficient.

The mechanism becoming free, the counterpoise *O* again falls and brings it back the necessary quantity for the lighting of the carbons; at this moment the arc is established.

From this moment each time that the resistance of the arc increases by the consumption of the carbons, the derived current augmenting in intensity, will cause the carbons to approach each other; and if this approach is too great, the fall of the rocking lever by disengaging the retaining click *g* will permit the break to widen the distance between them.

No. 3,522. James Atkinson, of 3, Nassington-road, Hampstead, London, engineer. "Improvements in gas-engines." 12th March, 1886.

The engine described has an inclined cylinder *A*, formed by forcing a cylindrical liner into a portion of the main framing of the engine, the space between this portion of the engine and the liner forming a water-jacket; the cylinder *A* is closed at its lower end by a cover, in which passages for the inlet of gas and air, and outlet for the exhaust are formed; the other end is left open and a single-acting piston *B* is fitted. The piston is connected by a link *C* to a pin *D*, which is fixed in the connecting-rod *E*, being attached to the crank *F*; the upper end of the rod *E* is fitted with another pin *G* forming a T-head to it: to the pin *G* one end of the links *N* is attached, the other end being connected to a fixed centre I, around which the links vibrate.

The piston has a peculiar motion imparted to it by the revolution of the crank pin *F*, and this peculiar motion enables the whole cycle of operations necessary to a compression gas-engine to be performed by one piston in a single-acting cylinder for each revolution of the crank—that is the gas and air are drawn in, compressed, ignited, expanded, doing the work and expelled once per revolution.

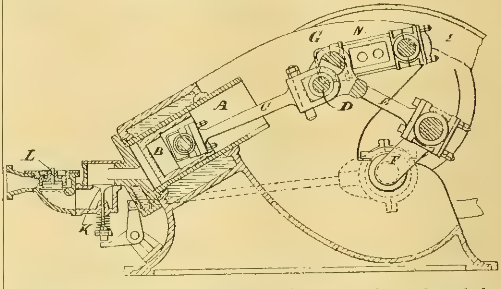
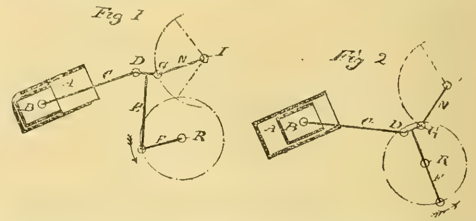
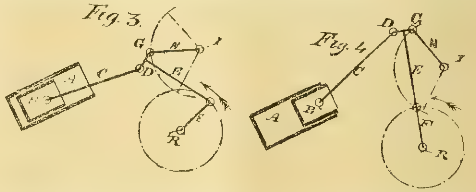


Fig. 1 shows the position of the crank *F*, the various rods, and the piston at the end of the exhausting stroke, and whilst in this position the piston may be worked as close to the cover as is consistent with




safety, so that the residuum may be thoroughly expelled if desired. As the crank *F* revolves in the direction shown by the arrow, the piston is moved into the position shown in Fig 2; during this movement the gas and air, forming an intermittent, homogeneous, explosive mixture, are drawn into the cylinder. The crank continuing to revolve moves the piston back, so as to compress the charge until the position shown in Fig. 3 is reached, when the charge is ready for ignition, after which the increased pressure due to ignition drives the piston into the position




shown in Fig. 4, thus imparting power to the crank shaft; the stored-up energy round during the rest of the revolution, the exhaust being driven out whilst the engine is passing from the position shown in Fig. 4 to that shown in Fig. 1.

The exhaust, admission, and governor valves are of a form commonly in use.

The working gear may be arranged in any suitable manner, the essential requirement being to obtain the peculiar piston movement which consists of four strokes for each revolution of the crank shaft; one of these strokes being used for drawing in the charge, one for compressing the charge, one for imparting power to the engine during the expansion of the ignited charge, and the other for expelling the exhaust; the lengths of these strokes and the points at which they commence and end, being under control as described in the specification. The cylinder being placed in any desired position in relation to the necessary rods, levers, and working centres, as may be most convenient and suitable. Also more than one cylinder may be used to form a combined engine, or a separate pump may be combined with a cylinder whose piston by means of the motion described gives two working strokes per revolution, the other two strokes being exhausting strokes, the charges being drawn in and compressed in the pump.

The relative proportions of the capacities in the cylinder *A*, when in the positions shown in Figs. 1 and 3, may be varied by altering the distance apart of the pins *D* and *G*, or their relative position to the crank pin, and also partly by the position of the main shaft centre *R*.

# Scientific News

## FOR GENERAL READERS.

Vol. I.] April, 1887. [No. 2.

CONTENTS.



## CURRENT EVENTS.

City and Guilds of London Institute.—A well-attended and very interesting conversazione was given by the Council of the City and Guilds of London Institute in the New Central Institution at South Kensington, on the evening of 16th March. The building is large, and apparently well arranged for accommodating students in the many branches of technical education which are taught. The thoroughly practical as well as scientific nature of the instruction given, was shown by the machines and apparatus used in the various laboratories and workshops. Prof. Unwin, F.R.S., explained the use of the 100-ton testing machine in the Engineering Laboratory, giving a practical illustration by breaking some bars of iron.

Prof. Ayrton also gave a short but very interesting demonstration to a crowded audience in the Physics Lecture Theatre, referring chiefly to Faraday's discovery of the principles on which the modern dynamo machine depends. By permission of the Royal Institution he was able to show some of the identical apparatus made with Faraday's own hands, and used by him fifty years ago. For instance, there was his first induction coil made with two pieces of covered wire wound round an ordinary curtain ring; and with this simple contrivance it was proved that after passing a current through one wire there was a second and independent current set up in the other wire as soon as the current passing through the first was stopped.

Professor Ayrton also showed his audience Faraday's development of this induction coil, by means of which the latter succeeded for the first time in obtaining an electric spark by the transference of mechanical work into electrical energy. This, in fact, was the forerunner of all the dynamo electric machines now used throughout the world, not only for electric-lighting but for electric-motors. He concluded by showing in operation several applications of electricity to modern uses. Demonstrations were also given by Mr. J. Sawyer on the Autotype Process; by Prof. Armstrong, F.R.S., on the Production of Madder Colours and Indigo from Coal; and by Prof. Austen-Roberts, F.R.S., on Methods used by the Japanese in Art Metal Work. On a future occasion we hope to give some particulars of this very promising institution.

Foul Air in Public Assemblies.—The waste of life that is due to breathing foul air is a quantity beyond the possibility of gauging, or even estimating; but, at any rate, it must be very great amongst people leading sedantry lives. It is a matter for congratulation, therefore, that some reliable tests are about to be made in this country on the subject. Dr. Russell, of Edinburgh, a member of the Public Health Committee, has taken the matter in hand, and has already made some tests. The first examinations were made at the beginning of last month, in the rooms of the Edinburgh Council Chamber. These, we understand, are to be the first of an extensive series of tests in which the air in schools, halls, theatres, and some of the churches in the northern capital, will be made the subject of examination. The investigations will be made by Dr. Hunter Stewart, who is the director, under Sir Douglas Maclagan, of the Public Health Laboratory, in the Edinburgh University. He will have associated with him Mr. Cosmo Burton, B.Sc., who will act as analyst during the tests.

The apparatus employed in making these tests will consist of three different sets. One will be used for testing for carbonic acid gas, a second for germs, and a third for organic matter. The following description of this apparatus is taken from a northern contemporary:—

"In connection with the analysis for carbonic acid, the air is pumped by a bellows into bottles with a capacity of a gallon and a half, the air from different heights being obtained by means of an adjustable india-rubber tube. In the analytical process a solution of baryta is used. This poured into the bottles containing the air absorbs the carbonic acid, and forms a white powder at the bottom of the vessel. A given quantity of baryta being capable of absorbing a given quantity of carbonic acid gas, the measurement of the baryta remaining in solution in the bottle gives, on a simple calculation, the quantity of carbonic acid gas which was in the amount of air sampled. For the collection of those mysterious germs which are never entirely absent from the atmosphere, and whose functions have not yet been satisfactorily determined, a glass tube about 2 inches in diameter and 2½ feet in length is used. This, coated internally with a transparent gelatine, in which the germs can live and thrive, is brought to the place, the air of which is to be tested, germ-free. A reversing aspirator is affixed to it, and a measured quantity of air is then drawn through the tube, on the sides of which the germs deposit themselves. At first these are not distinguishable by the naked eye; but in the course of three or four days they have formed colonies and multiplied so exceedingly that a glass is no longer needed to pick them out. Ultimately they are subjected to examination under high microscopic power, so as to determine, if possible, their genera, and whether or not they are disease-producing germs. They are mostly vegetable, and belong to the very lowest order of things endowed with life. For determining the amount of organic matter the apparatus used consists of a set of six bottles filled with the purest distilled water, and connected together by means of tubes. The aspirator is put on to one end, and the air is then sucked into the bottles drop by drop, and thoroughly washed in its passage through them. No perceptible discolouration of the water ensues by this washing of the air, but the water acquires a stuffy, disagreeable smell, the same as is experienced in a badly ventilated chamber. The water thus impregnated with organic matter is then emptied into a vessel for analysis."

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The Microphone.—At a recent meeting of the Society of Telegraph Engineers, Professor Hughes gave some particulars of an experiment he had made by submerging a microphone in a public bath. By the unassisted ear no sounds could be distinguished, but by the aid of the microphone a great confusion of sounds was revealed, doors being shut, footsteps, voices, water flowing, all mingled together. This proved the vibratory power of water, and a practical application of the phenomenon is found in the fact that the microphone is now part of the regular equipment of officers of certain water companies in Germany, where it is used to detect leakage from the pipes by the noise of the waterflow.

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The British Association.—The principal officers for the Manchester meeting of the British Association, to begin on August 31, under the presidency of Sir Henry Roscoe, have now been selected. The following will be the Presidents of the various Sections:—Section A, Mathematics and Physics, Sir Robert S. Ball, Astronomer Royal for Ireland; B, Chemistry, Dr. Edward Schunck, F.R.S.; C, Geology, Dr. Henry Woodward, F.R.S.; D, Biology, Prof. A Newton, F.R.S.; E, Geography, General Sir Charles Warren, R.E., G.C.M.G.; F, Economic Science, Dr. Robert Giffen; G, Mechanical Science, Prof. Osborne Reynolds, F.R.S. For Section H, Anthropology, a President has not yet been chosen. One of the public lectures will be given by Prof. H. B. Dixon, who has taken as his subject "The Rate of Explosions in Gases." The lecture to the working classes will be given by Prof. George Forbes. It is expected that, socially, the Manchester meeting will be one of the most brilliant ever held. A very large sum has already been subscribed, and liberal arrangements are being made for excursions and other entertainments.

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Railway Brakes.—The paper read before the Society of Arts on the 9th of March, by Mr. William P. Marshall, the late Secretary of the Institution of Mechanical Engineers, on Railway Brakes, forms an important addition to the popular literature of the railway. The author gave simple descriptions, such as could be understood by a plain man, of the various kinds of brakes in use, commencing with the simple brake, and treating of chain brakes, vacuum and compressed-air brakes of various kinds, both automatic and non-automatic, and the various adjuncts connected with them. A good discussion followed, which extended over a second sitting. The subject is an important one, to which the general public might well turn their attention, considering how closely the efficiency of railway brakes affects their safety and comfort.

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Sewing Machines afforded another mechanical subject of popular interest for a paper read before the Society of Arts. Mr. John W. Urquhart was the author, and he had a very difficult task in putting the recent advances in sewing machinery forward in a manner that could be understood by any but experts. There is not, probably, above one user of sewing machines in a thousand who has mastered the principles of the mechanism, and for this reason Mr. Urquhart's paper was additionally welcome.

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The Mineral Resources of the United States.—In a report of the U.S. Geological Survey on the mineral resources of the United States for 1885, it is stated that the total mineral product is valued at 428,521,356 dols., an increase of 15,306,608 dols. over 1884. Among seventy mineral substances cited, coal is the most important, showing a total value of 159,019,596 dols. An increase is shown in the production of coke, natural gas, gold, silver, copper, zinc, quicksilver, nickel, aluminium, lime, salt, cement, phosphate rock, manganese, and cobalt oxide, while the production of coal, petroleum, pig iron, lead, precious stones, and mineral waters decreased. According to the report, it is probable that the total output of 1886 was much greater than that of 1885, and even larger than that of 1882.

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Artificial Rubies.—At a recent meeting of the *Académie des Sciences*, a report was read by M. Fremy on the artificial production of rubies. We are indebted to our contemporary, *La Nature*, for the following details. This subject has already been treated with varying success by MM. Ebelmen, Gaudin, Cazon, and Debray, and in 1877 M. Fremy himself obtained some remarkable results in conjunction with M. Feil, whose recent death is now so much deplored. Two methods had then been in operation, viz.: 1st, The fusion at a white-red heat of a mixture of alumina and minium with a small quantity of bichromate of potash; and, 2nd, The treatment at the same temperature of alumina, to which were added baric fluoride and a very little chromic acid. In both characteristic crystals were obtained, but they had a tendency to be laminated, and were too small for cutting. Since then M. Fremy has endeavoured to obtain still better results, and this time has resumed his experiments with the co-operation of M. Verneuil. The alumina was mixed with calcic fluoride, and was subjected to the action of heat, the crucible being made of platinum or alumina. In every case the crystallization sought for was obtained, and M. Fremy does not hide the astonishment he felt on seeing large masses of alumina transformed into crystals by a trifling addition of the fluoride. Diminishing gradually the proportion of the latter, he finally succeeded with one part of fluoride mixed with twelve parts of alumina. He even succeeded in crystallising the oxide on heating it in a crucible containing some fluoride, but separated from it by a finely-perforated partition. Nothing could justify more thoroughly the previous opinions of such authorities as M. H. Sainte-Claire Deville and M. Debray, as to the important influence of fluorides in the formation of minerals; and theoretical geology as well as practical mineralogy will both gain by these new experiments of M. Fremy.

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The Air Brush is a new appliance which has recently been introduced in America. It is a tool for applying liquid pigments to paper or other surfaces in the production of pictures. It operates in the following manner. The artist supplies liquid colour from a brush to a spoon-like receiver. Through this liquid a fine needle darts rapidly backwards and forwards, its wetted point being carried beyond the edge of the spoon. A strong current of air directed on the point of the needle blows the colour in fine spray against the paper. When the point is held near the paper a fine line of colour is drawn, and this is widened by drawing the point further off. The greater or less length of the stroke of the needle, as well as the current of compressed air playing on it, are under control of the artist's thumb and foot, the latter being used to work the bellows supplying the air. The instrument has been submitted to the Sub-Committee on Science and Arts of the Franklin Institute, who have reported that it is an acquisition of rare value in the hands of an accomplished draughtsman, and that it is worthy of the highest award the Franklin Institute can bestow. The Air Brush Manufacturing Company of Rockford, Illinois, U.S., are the makers of this novel instrument.

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A New Disinfectant for Sewage.—Mr. Carl Liesenberg has recently taken out a patent in Germany for the purification of refuse water by means of sodium ferrate. This product is obtained in a furnace by melting crude soda with suitable iron ores, finely powdered. When Bauxite clay ironstone and cognate ores are used, a sodium aluminate is also formed, which is supposed to be of no value for the purification of the water. Neither is it suitable for a mordant, for artificial stones, or for glass manufacture, as, for these purposes, the sodium aluminate must be perfectly free from iron, which is not the case in the bye-product formed by the patented process. The water to be purified is treated and cleared with lime in the ordinary way; then the sodium ferrate ($Na_2\ Fe_2\ O_4$) is added, and this yields with the water ferric hydrate and sodic hydrate. The ferric hydrate forms the well-known reddish flakes, which rapidly settle and carry down with them any suspended matter.

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Manganese Steel is a new alloy which is being introduced by Messrs. Pfeil and Co., of Clerkenwell. Some remarkable tests with this material have recently been made before a party of gentlemen interested in metallurgical operations, and the results show that this steel possesses unusual qualities. Bolts were bent over by hammering through about 120 degrees in the threaded part without showing the least sign of distress, and nuts were hammered down until the screwed way was nearly closed, with similar results. The necks of the bolts were also bent 120 degrees and were only broken through by being hammered back again, the metal showing an excellent fracture. Bolts and nuts of this steel are now being used in the Royal dockyards and in the carriage department at the Royal Arsenal, Woolwich.

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The Growth of Children.—For three years Mr. M. Hansen, the director of the Deaf and Dumb Institution at Copenhagen, has weighed and measured daily all his pupils, and he reports having made the following observations:—The growth of children is not regular or progressive, but proceeds at intervals after rest. Their weight increases only after periods of equilibrium. When the weight increases the height remains nearly stationary, and vice versâ. The maximum increase in height corresponds with a period of minimum increase of weight. These variations are also affected by the seasons, thus during the autumn and the beginning of winter the child increases in weight, but its height is hardly changed. On the other hand, during the spring the height is appreciably increased, but there is no addition to the weight.

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A Long Hydraulic Lift.—The Winchester House Company, of Old Broad-street, City, has just started a hydraulic passenger-lift of exceptional size. It has a total travel of 90 feet, and a solid steel ram measuring $5\frac{3}{4}$ in. in diameter by about 95 feet in length. Two other lifts in the building have a travel of 80 feet each, and all work at a speed of 250 feet per minute. They are on Stevens' and Major's hydraulic balance system, and are made by Messrs. Archibald Smith and Stevens.

## GENERAL NOTES.

A Deep Bore-Hole.—It is reported that a depth of over 5,200 feet has been reached by some Prussian mining engineers in boring at Schladerbach, near Halle.

Another Telephone.—The *Times* gives particulars of a new telephone invented by Dr. Hertz, which has been tried between Paris and Brussels. It is called the "Micro-telephone Push Button."

Telephonic Communication is now complete between Croydon and London. The wire is ten miles in length, and runs along the Brighton Railway line, a substantial rental being paid to the Post-office for the privilege.

The Electric Light at Gothenburg.—It is announced that a part of Gothenburg is to be lighted by electricity, the corporation having made a contract with a local firm to supply arc lights for the principal streets and squares.

Amateur Photography.—The London Stereoscopic Company have issued, in a revised and enlarged form, their handbook, "The A B C of Photography." In this, practical information is given not only to beginners but also to "proficient amateurs."

The Trans-Caspian Railway.—In a recent number of the *Fortnightly Review*, Professor Arminius Vambery gives an interesting account of the Transcaspian Railway, in which he describes the use of naphtha as a fuel for working the line.

Diamond Drilling in Australia.—A diamond drill boring, fifteen miles from Sydney, has struck a seam of coal at 2,227 feet. This, in connection with other bores, is said to prove the continuity of the main coal seam from Wollongong to Newcastle.

A Tunnel between Italy and Sicily is in contemplation. Our contemporary, *Nature*, gives some particulars, from which we gather that the estimated cost is seventy-one million francs, and the time required to complete the work would be from four to six years.

The Steel Works of the country have recently received an important addition by the erection at the Britannia Iron Works, Middlesborough, of three Siemens-Martin 18-ton furnaces of a capacity of about 200 tons of steel per week. Three more furnaces are rapidly approaching completion, and when these are finished about 1200 tons of steel will be made, if required, per week.

Subsidence in the Salt Districts.—At Northwich, in Cheshire, a startling subsidence has lately occurred in Castle Stone, one of the main thoroughfares. The foundation of a shop, together with about ten yards of the adjoining footpath, sank into a deep pit, which soon became filled with water. Shortly after a pit four yards in diameter and five yards deep was suddenly formed in the Hartford volunteer drill-shed.

A New Optical Glass.—The invention of a new optical glass is said to be creating a sensation in the German scientific world. The glass, owing to its great refractory power, promises to be of marked influence in practical optics, inasmuch as it will admit of the production of lenses of short focal width, such as it has hitherto been impossible to obtain. For microscopic photography it will be of the greatest importance.

The Stevens Institute.—The *Stevens Indicator*, which is the name of the journal published by the Stevens Institute of Technology, has appeared in a new form as a quarterly, and the first number gives an article on the general prosperity and work of the Institute, followed by articles on the Institute's electrical steam-engine testing facilities, and on several subjects of engineering interest relating to matters outside the Institute.

The British Association Meeting.—In our last issue we stated that the Autumn meeting of the Iron and Steel Institute at Manchester would be followed by that of the British Association, to be held in the same city. We should have stated that the former society will follow the latter. The British Association meeting is to commence on the 31st of August and terminate on 7th of September.

Two New Borings for Salt are in progress on the south side of the Tees, below Middlesborough. The first is being made by Messrs. Pease and Partners, commonly known as the Middlesborough Owners. The contract for boring has been let to the Cumberland Diamond Rock-Boring Company, and the depth at which it is expected salt will be found is about 1,000 feet. The second hole will probably be carried about the same depth. The thickness of the seam of salt is 80 feet.

A New Form of Battery.—Dr. Lugo, of New York, has devised a form of battery which is described as giving a current of great constancy. The result is obtained by the device of employing three distinct liquids. The zinc is placed in the outer cell in an alkaline solution; next comes a porous cell containing chloride of copper, and in this stands a hollow cylinder of carbon containing hydrochloric acid. The acid dissolves the copper which is liberated at the surface of the carbon, and maintains the strength of the chloride of copper solution perfectly constant.

Niagara Falls.—Examinations recently made show the average recession along the contour of the Niagara Horseshoe Fall since 1842 to have been 2·4 feet per year. At the point where the acute angle is formed the recession from 1842 to 1875 was over 100 feet, and from 1875 to 1886 more than 200 feet. The wearing away of the American Fall since 1842 has been but slight. The heights of the falls above the level of the water were determined by the engineers of the United States Geological Survey on August 17th, 1886, as follows: American Fall, 167 feet; Horseshoe Fall, 159 feet.

The Bicycle, as a means of locomotion to soldiers, especially those employed as messengers or orderlies, has, according to the *Broad Arrow*, been for some months upon trial at the Joinville Training School in France, and the result, it is said, has been satisfactory beyond expectation. An inspection of a couple of dozen selected pupils, who have been under bicycle and tricycle tuition, was held last week by the French War Minister, and great proficiency was exhibited by the riders of this novel cavalry. Some of the evolutions were of an intricate nature, and excited much admiration on the part of the general and his staff.

The Photographic Convention of the United Kingdom.—The following information is extracted from a circular of the Edinburgh Photographic Society:—"It has been decided by the executive committee that the Convention this year shall take place at Glasgow, on Monday, July 4th, and extend over one week. The arrangements will take the following form:—Excursions with the camera daily, to places of interest in the neighbourhood, either by coach, rail, or other conveyance, under the direction of specially appointed leaders. The evenings will be principally set apart for the reading of papers, demonstrations, exhibition of apparatus, etc.

Liquid Fuel.—From what is currently reported of the use of liquid fuel on the Pacific coast, the results there do not seem to have proved highly satisfactory. A San Francisco paper, for example, has just published a paragraph to the effect that the ferryboats plying between that city and

Oakland, which had been fitted up for burning petroleum, have now, after several months' experience, gone back to coal. The economy, so far as the fuel itself is concerned, is claimed to be decidedly in favour of the oil, but a rapid deterioration of the iron of both furnaces and boilers was noticed, entailing a heavy and constant expense for repairs and renewals.

Pita Fibre.—The American Consul in Honduras (Mr. Burchard) gives some particulars of the pita plant. It grows spontaneously and in apparently inexhaustible quantities by the margin of the rivers and lagoons of that country at any point below an altitude of 2,000 feet. The fibre is susceptible of a very large number of uses. The people of Honduras convert it into thread for sewing boots and shoes, and into nets, fish lines, and cordage. The finest hammocks are made from it. Small quantities which have been sent to the market have been manufactured into handkerchiefs, laces, ribbons, false hair, and wigs. The difficulty is to decorticate the plant without rotting or otherwise injuring the fibre.

The Discoverer of Saccharin.—In a contribution to the *American Chemical Journal*, on Benzoic Sulphinide, Mr. Ira Remsen remarks:—"This substance has recently come into some prominence under the name 'Saccharin,' which is given to it on account of its sweet taste. In the notices of saccharin, even in scientific journals, the statement is constantly made that the substance was discovered by Fahlberg. The statement needs modification. As a matter of fact the substance came to light in the course of an investigation which Fahlberg undertook at my suggestion, and carried on under my direction; and it was first described in a paper by myself and Fahlberg, which appeared in the *Berichte der Deutschen Chemischen Gessellschaft*, vol. xii., p. 469. A more detailed account was published later in the *American Chemical Journal*."

The Muir Glacier.—A paper in the *American Journal of Science*, on "The Muir Glacier," by G. Frederick Wright, contains an exhaustive study of this interesting glacier, which lies in the Alpine region of Alaska, at the head of Muir Inlet, Glacier Bay, in 58 deg. 50 min. N. lat., 136 deg. 40 min. W. long. It forms a frozen stream some 5,000 feet wide by 700 feet deep, entering the inlet during the month of August, at a mean rate of 40 feet, or 140,000,000 cubic feet per day. The vertical front at the water's edge is from 250 feet to 300 feet, and from this front icebergs are continually breaking away, some many hundred feet long, with a volume of 40,000,000 cubic feet. The glacier appears to be rapidly retreating, there being indications that even since the beginning of this century it has receded several miles up the inlet, and fallen 1,000 or 1,500 feet.

The Wesley Naturalist is a new monthly publication which first saw the light at the same time that we ourselves did—namely, on the first day of last month. It is the journal of the Wesley Scientific Society. Its object is to promote and combine the study of intellectual truth and moral truth. The editors are the Rev. W. H. Dallinger, LL.D., F.R.S., Pres. R.M.S., F.L.S.; the Rev. W. Spiers, M.A., F.G.S., F.R.M.S; and the Rev. Hilderic Friend, F.L.S. The first number contains an article by Mr. F. T. Law, F.R.M.S., on "The Land of the Northern Holy Grass," after which follow "Studies for the Month," which include astronomy, anthropology and antiquities, biology, botany, chemistry, conchology, entomology, geology, microscopy, ornithology, photography, and marine zoology. It will be seen that our twin brother in science covers a very wide field, and with the guarantee of the many eminent names that are connected with the management it can hardly fail to succeed.

Torpedo Boats and Machine Guns.—A second-class torpedo boat sank at Portsmouth last month, after having on the previous day been fired into from a machine gun on board the *Excellent*. The object of the experiment was to ascertain the effect of machine-gun fire on torpedo craft in action, with the conditions in favour of the machine gun. Ten days before three rounds had been fired, and all the shots missed, although the *Excellent* was stationary, and the distance of the range was known. On the second trial, the boat was moored broadside on at a distance of 200 yards, four rounds were fired, and the boat was struck in the bows. She sank on the next afternoon, twenty-six hours after the attack. The result of the experiment is regarded as favourable to the torpedo boat, which could have discharged all her weapons after she had been fired into. The boat is now being raised, and will be handed over to the Veron authorities, who will fire at her from another torpedo boat while in motion and at an unknown distance.

The American Exhibition.—For some long time there have been rumours and reports of a wonderful exhibition, consisting entirely of American products, that was to be held at Earl's Court. The effect of considerable delay in opening the show has made the British public somewhat sceptical whether it would ever be held at all. There is, however, very little doubt about the matter now, for considerable progress has been made in the erection of the buildings, and when the recent bad weather came on the extensive ornamental grounds were being energetically pushed forward. We don't know to what extent American science will be represented, but there can hardly fail to be a good deal that would interest the readers of this journal, if only in the machinery department. This should be fairly extensive, if one may judge by the foundations that are being put in for motive power. It is a bold and original idea to hold an exhibition of one country's products in the capital of another country, but the plan is based on true principles.

Nazography.—It is announced that a new journal is to appear as the organ of the science of nazography. According to *La Science en Famille*, the author of the system states that nazography permits of divining the character, habits, and inclination of people by a simple inspection of their noses. According to this science it is desirable that the nose should be as long as possible, this being a sign of merit, power, and genius. For example, Napoleon and Cæsar both had large noses. A straight nose denotes a just, serious, fine, judicious, and energetic mind; the Roman nose, a propensity for adventure; and a wide nose with open nostrils is a mark of great sensuality. A cleft nose shows benevolence—it was the nose of St. Vincent de Paul. The curved, fleshy nose is a mark of domination and cruelty. Catherine de Medici and Elizabeth of England had noses of this kind. The curved, thin nose, on the contrary, is a mark of a brilliant mind, but vain and disposed to be ironical. It is the nose of a dreamer, a poet, or a critic. If the line of the nose is re-entrant, that is, if the nose is turned up, it denotes that its owner has a weak mind, sometimes coarse, and generally playful, pleasant, or frolicsome.

Nitrate of Bismuth for Distilleries.—The ordinary fermentation process, particularly of molasses and beet-root and sugar solutions, may yield, besides the desired alcohol, also secondary products, which impair the taste and quality of the spirits, and not rarely augment its intoxicating capacity in a decidedly unpleasant manner. The formation of these secondary products is due to the presence of certain micro-organisms, and MM. Gayon and Dupetit have carried on a prolonged research into the methods of eliminating them. Their account is given in the "Comptus Rendus" 103, 1886, p. 853. The use of tannin they found beneficial, and nitrate of bismuth proved a success, laboratory tests showing that the harmful microbes could be entirely destroyed by this salt. Larger and very valuable experiments were then made at the important distilleries of Lement at Bordeaux, and of Bernard and Tilloy at Courrières. When one ten-thousandth part of nitrate of bismuth was added to the fermenting liquor, the fermentation proceeded with remarkable regularity, and there was always a gain in the yield of alcohol of from two to twelve per cent. The advantage of this method was confirmed by parallel tests without the addition of bismuth.

The Bleaching of Paper and Linen Yarns is being tried in France, by a new process which is about to be introduced into this country. If successful it will very materially affect the manufacture of bleaching powder and similar compounds. M. Hermite, the inventor, has found that when a solution of magnesium chloride is electrolysed by a powerful electric current, a compound is formed similar in properties to bleaching powder, and it can be produced at a much cheaper rate. The advantages claimed by the inventor and patentees for their product are rapidity of action and small expenditure in production after the initial cost of plant. The new system has been found to answer admirably for the bleaching of flax yarn, and similar good results have been obtained with paper pulp. The bleaching efficiency of the liquid is said to be greater than that of a solution of bleaching powder of the same strength, and the bleaching action is completed in a much shorter time than in the old process. The cost of production is estimated at about £2 10s. for a quantity of material which would do the work of one ton of bleaching powder. The present price of the latter is now £8 10s., so that the new process should rapidly come into general use in those industries in which rapid and economic bleaching on a large scale is required.

Rules for identifying Electrical Conductors.—Many troubles and annoyances would doubtless be avoided if certain conventional rules were universally adopted in the fixing of electrical conductors. At present there is seldom any difference in the colour of the positive and negative wires, nor is any fixed rule followed in laying them, and frequently it is most troublesome to find out which is which. It is especially difficult for amateurs or the inexperienced users of electricity. With this in view, our contemporary *La Nature* calls attention to the following useful rules, which it is suggested should be universally adopted :—

1. All positive wires to be placed to the left of, and above the negative wires.

2. All negative wires to be placed to the right of, and below the positive wires.

3. All positive wires to be coloured bright red (as is already done to denote the positive pole of accumulators).

4. All negative wires to be coloured black.

It is further suggested that all instruments of measurement should have their needles arranged to move from positive to negative, in the same direction as the hands of a watch. If these simple rules were well applied, much time would often be saved, and many mistakes avoided in the coupling up of apparatus.

Pepperette.—Some months ago the spice grinders throughout England received a letter from a firm in Leghorn offering to supply them, at a low price, with an article which was described as *poivrette*, or pepperette, for admixture with pepper. After a time this substance came under the notice of the public authorities, but for long the true character of *poivrette* remained a mystery. Under the microscope it had a close resemblance to pepper in colour, appearance, and cells. It was hard and tasteless and was certainly not pepper, but beyond the fact that it was a dense ligneous substance it baffled the skill of the analysts. The mystery was at last cleared up by Dr. Campbell Brown, public analyst for Lancashire. Reflecting that olives were a home product of Leghorn, he thought the stones might be the adulterant. He had some olive stones ground, and the whole problem was solved. *Poivrette* was simply ground olive stones. In his certificate produced during some recent prosecutions, Dr. Campbell Brown describes pepperette as "a hard, tasteless, woody substance, absolutely worthless, composed of ground olive stones, imported into this country from Italy and sold at 1d. per lb. for the express purpose of being used for fraudulently increasing the weight of pepper." Pepper is sold wholesale for about 1s. 4d. per lb., and it would probably not be an exaggeration to say that a pepper grinder in a considerable way of business introducing 15 per cent. of the *poivrette* into his manufacture would net £6,000 a year by the adulteration. Prosecutions have been instituted, and they have not been without practical effect. It is now announced that the manufacture of *poivrette* at Leghorn has been discontinued. It has just made its appearance in America, however, and there is an evident desire to open the illegitimate trade in the country that gave birth to the wooden nutmeg.

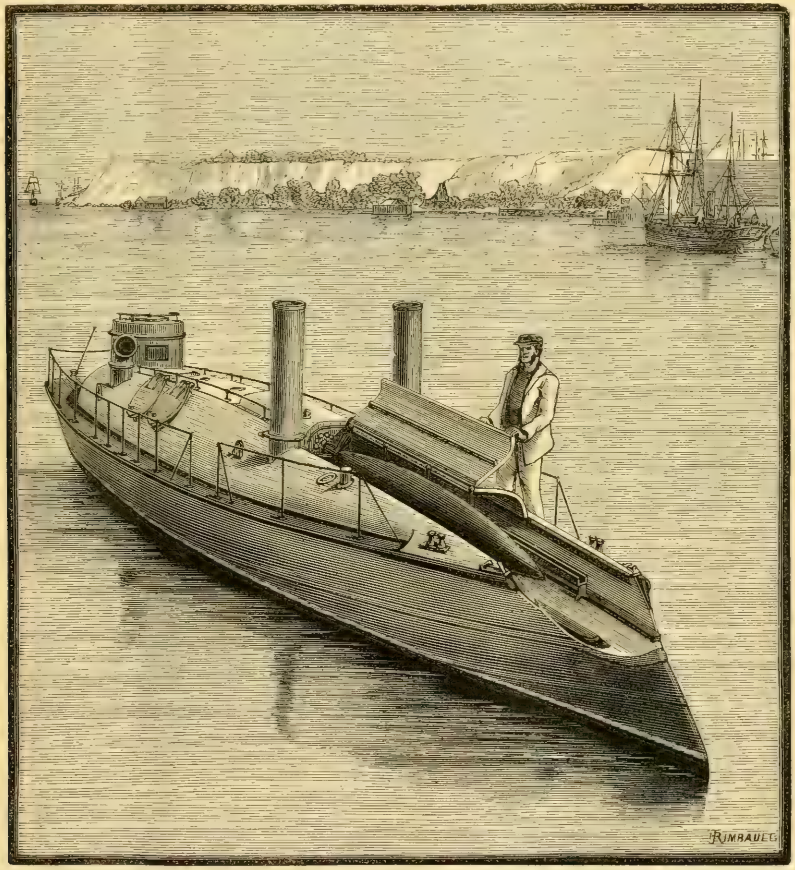
The Slag from the Thomas Gilchrist Process for making steel has long been supposed to have valuable properties as a manure. In the Bessemer convertor, there is a lining of lime which, in the process of manufacturing the steel, takes up a large percentage of phosphorus, in the form of phosphoric acid. Phosphate of lime has been used as an artificial manure, in a variety of forms, with very beneficial results on most lands. It was thought that the basic cinder obtained in the Thomas Gilchrist process might, from its large percentage of lime and phosphoric acid, have a manurial value. Some two or three years ago, experiments in this direction were undertaken in Germany by M. Fleisher and others, and from the data which they obtained, it appeared that under certain conditions basic slag had a very marked influence upon crops grown on soils which had been top dressed with it. It was ground into a very fine powder, and then the acids of the soil were able to dissolve the phosphoric acid which it contained; and it was then in a condition to be readily assimilated by plants. Attention is again being called to this point in consequence of a series of similar experiments which have been carried out by Dr. Munro, at Downton, for the North Eastern Steel Company, and which fully confirm the earlier experiments of the German investigators. It was thought that probably the slag would be more efficacious if it were first converted into a "superphosphate," in a similar manner to bones; but Dr. Munro and Mr. Wrightson seem to think that this is unnecessary, if care be taken to have the basic cinder in as pure a state of division as possible. As basic slag is a waste product, and hitherto has had no industrial application, it ought to be obtainable at a much cheaper rate than the Canadian apatite, coprolites, and bone manures which have until recently been the chief artificial fertilisers used in agriculture. Dr. Griffiths has recently, in papers read before the Chemical Society of London, advocated the use of iron sulphate as a manure, and as basic slag contains a considerable quantity of iron in the same condition of oxidation as in ferrous sulphate, it may also have some effect upon the manurial value of the Thomas-Gilchrist slag.

## THE FISH TORPEDO.

PERHAPS no invention ever gained a reputation so quickly and so cheaply as the Whitehead or Fish Torpedo. The idea of its construction was first suggested by an Austrian marine artillery officer, who is now dead. In the year 1864 Mr. Robert Whitehead, who was acting in the capacity of manager to an iron-works at Fiume, a seaport in Austria, situated at the head of the Adriatic Gulf, took the matter up, and after a long series of experiments, produced the Whitehead Torpedo.

In the year 1870 Mr. Whitehead came to England, and put his invention before the British Admiralty. He was afforded a trial, and succeeded in destroying an old hulk which was moored at the mouth of the river Medway. From that date, the fortune of the Whitehead torpedo, or rather of its inventor, may be said to have been made. He received at the time seventeen thousand pounds for the secret of his invention.* Since that date nearly all the European Governments have purchased Mr. Whitehead's secret, in addition to which a large and doubtless lucrative business has been carried on at Fiume in the manufacture of the weapons themselves.

The Whitehead Torpedo consists mainly of a steel outer shell, which is from fourteen to sixteen inches in diameter in the centre, and from thence it tapers to a point at each end. The length is either fourteen feet or nineteen feet. It is propelled by means of two screws, which are actuated by a small engine as in an ordinary steamboat. In place, however, of the boiler and furnace, which of course would be impossible in such a position, there is a strong reservoir made of Whitworth fluid pressed-steel. Into this, air is pumped until it has reached a pressure of about 1,000 lbs. to the square inch, although in the most recent Woolwich-made torpedoes the pressure has been increased by 200 lbs. additional, bringing it to 1,200 lbs. to the square inch. In the front part of the weapon is placed the explosive charge. By making the bows bluffer, which, however, has not detracted from the speed, more storage




SECOND-CLASS YARROW TORPEDO-BOAT, SHOWING WHITEHEAD TORPEDO IN POSITION.

* Sleeman on "Torpedoes," published by Griffin and Co.

room has been found for the charge, which now consists of 70 lbs. of damp gun cotton. The original Woolwich Whitehead torpedo carried only 33 lbs. of gun cotton.

The great feature about the Whitehead torpedo is the mechanism by which the depth at which it travels in the water is provided for. It will be easily understood that if the specific gravity of the whole weapon were less than that of water, it would float at the surface, more or less out of water; while if the specific gravity were greater than water, it would certainly sink, for there are no half measures about flotation. It is this part of the apparatus which constitutes the secret, and so important was this considered that all persons who were entrusted with the details had to make a declaration that they would not make them known.

The Turkish Government did not purchase this secret from Mr. Whitehead, but they became acquainted with it through a torpedo being fired at their ships by the Russians, during the Russo-Turkish war. This weapon missed its mark and came ashore unexploded. It was taken possession of by the Turks, who thus had an opportunity of studying its mechanism without being under any engagement as to secrecy. Lieutenant Sleeman was at the time in the Ottoman Navy, and in his book on the torpedo he thus describes this part of the weapon: "The torpedo is maintained at the desired depth by means of certain mechanical apparatus contained within the adjustment chamber, and which constitutes what is called the secret of the fish torpedo. This chamber is connected by screws to the foremost and after chambers of the torpedo in such a manner that by means of a number of holes bored round the circumference, the faces of the chamber are exposed to the pressure of the water, which varies with the depth to which the torpedo descends. Within the adjustment chamber is an endless strong spiral spring attached to the after face of the chamber, and so arranged, that after being set to a certain tension, capable of resisting an equivalent pressure on the outside of the aforesaid face, any increase or decrease in this exterior pressure will cause the spiral spring to work a rod by which the horizontal rudders of the torpedo are regulated, and thus the desired depth for which the spring is set is maintained. The course of the torpedo is represented by a series of curves, above and below the line, corresponding to the depth set for. These curves gradually decrease, until at 100 yards' distance, they are so small that the path is almost identical with a straight line." There is also fitted a swinging weight which assists the action.

The weapon can be adjusted to explode either by contact with the side of the attacked vessel, or at the expiration of a certain time. It can be set to travel at any depth between five and fifteen feet. It can be arranged at will to either float or sink at the end of a run, so that if it were set for contact firing, and did not hit its mark, it could not be captured by the enemy. At the same time it can be recovered after a practice run in peace time. The standard speed for a modern Woolwich Whitehead torpedo is at the rate of twenty-four and a half knots an hour, and it will travel at this rate for 600 yards. It is said, however,* that twenty-six knots has been reached for this distance, whilst one torpedo ran for 400 yards at the rate of twenty-seven knots an hour. It is needless to say that no vessel that ever yet floated can attain this speed.

The method of ejecting the fish torpedo from a vessel is an important feature, and one on which its efficiency to a great extent depends. In those wonderful craft, the torpedo boats, which are built solely for operating with this weapon, there are two methods of sending it on its errand of destruction. In the first a tube or gun is built into the structure of the vessel itself, the launching then being effected over the bow. Our illustration shows a torpedo boat constructed by Messrs. Yarrow and Co., the well-known builders of these craft. The torpedo may be plainly seen in its berth, but when the cover is shut it is snugly tucked away out of sight. In the larger boats of this class two torpedo tubes are placed side by side. The second method of firing is by torpedo tubes, or guns, as they are generally called, being mounted separately on deck. They are generally fixed on a turntable, so that they can be turned to point towards the enemy without moving the boat. In the built-in system the vessel itself must be manœuvred to point to the object; often no easy matter in a sea-way.

The launching impulse can be given either by compressed air, steam, or gunpowder. There is a small cylinder at the rear of the tube, and in this a piston works, having a projecting piston-rod which is arranged to strike the end of the torpedo when the launching is to be effected. On the compressed air or steam being admitted to the cylinder, or the gunpowder being exploded, the piston is thrust forward, and the impulse is thus given. The gunpowder method is the most recent, and is generally considered the most efficient system of launching.

The reputation of the Whitehead torpedo as an engine of destruction has been somewhat shaken of late, in consequence of experiments made at Portsmouth on H.M.S. *Resistance*, an obsolete ironclad which was condemned to a species of naval vivisection in the interests of science. It would take too much space to describe the trials that took place, but it will be sufficient to say that the torpedo failed to actually sink the ship, although exploded in contact with her side. This was altogether an unexpected result, and naval men have begun to think lately that they have been taking the enormous destructive powers with which the torpedo has been credited a little too much on trust. Whatever may be said, however, there is no doubt but that the fish torpedo is a weapon of enormous possibilities, and no maritime nation can afford to neglect it. Whether these possibilities could be realised in actual warfare, we hope will remain for ever a sealed book.

* See *Engineering* of October 22nd, 1886.

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Electrical Resistance of Bodies when in the Magnetic Field.—Dr. Jaé has continued the experiments of Thomson and Righi, which prove that the electrical resistances of iron and nickel (paramagnetic or simply magnetic bodies) and of bismuth (the most strongly diamagnetic body) undergo sensible changes, if the substances are placed in a magnetic field. There appears to exist a connection between this phenomena and the Hall effect. Dr. Jaé used small antimony cylinders, with copper wires soldered to the ends, and electromagnets excited by cells or a dynamo. The cylinders were cast in little glass tubes, the glass being afterwards removed by repeated cooling and heating. When in the magnetic field the resistance was always increased, independently of the direction of the current; but more strongly in a transverse direction than along the longitudinal axis. Cobalt was employed in the form of fine lamellæ; if their plane was normal to the lines of force the electrical resistance decreased; if held parallel to the lines of force, and so that the current had the same direction, there was an increase. Thus the antimony sides with the bismuth, and the cobalt with iron and nickel, as analogy would lead one to expect.—*La Lumière Electrique*, January 23rd, 1887.

A Phantom Army.—In Vidovec, a Hungarian village near Warasdin, the belief of an approaching war has seized hold of the entire population. A splendid Fata Morgana was observed during three consecutive days on the wide plains around the village. Infantry could be seen performing exercises. The phenomenon lasted several hours, and finally the soldiers disappeared in mid-air.

The fastest run yet made across the Atlantic was accomplished by the *Etruria* last month. The time occupied was 6 days 6 hours and 18 minutes.

## NOTES ON THE HEATING OF BUILDINGS.

### No. 1.—Hot-Water Circulation.

THE efficient and economical heating of buildings is of such great importance that we propose to consider some of the principles which underlie the chief systems in use. This, we trust, will not only assist our readers to appreciate the laws on which success depends, and so ensure

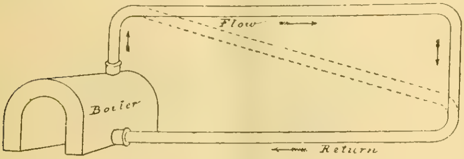



Fig. 1.

more profitable results being obtained; but will also lead them to see that the subject has really many points of scientific interest. In the present article we deal with heating by a circulation of hot water; and in the following numbers we hope to refer to heating by steam, by hot air, by fire, and by gas.

There is no country in which hot water is so extensively used for heating buildings as in England. This is especially the case in relation to glass-houses, and it is doubtless due

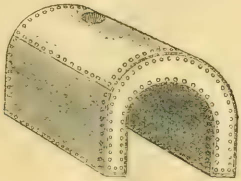


Fig. 3.

in great measure to the peculiarities of our climate. The number of persons who use circulating hot water for their dwellings or glass-houses is in fact enormous, and yet we fear there are very few who correctly understand the *principles* on which the satisfactory working of such a system depends. Usually people are content to leave the matter in the hands of a builder or "practical man," who in his turn is often ignorantly content to rely solely on rule of thumb.

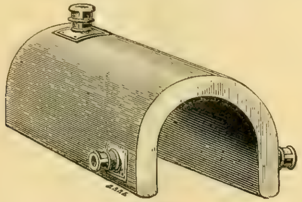


Fig. 4.

This naturally leads to blunders and alterations, for which the client is generally made to pay, while at the same time there is no certainty that in the end the efficiency of the system is what it should be. There are, of course, some well-known firms of hot-water engineers who fully understand their work, and do it well, and we do not refer to them. We speak of the many, not of the few.

The first essential is to understand why the water circulates, and for this purpose let us consider Fig. 1, which represents a simple form of boiler and pipes generally used. If the boiler and pipes are charged with water, and the fire is lighted, the temperature of the water in the boiler will be raised; this will render it less dense, and then there will be an effort on its part to rise and leave the boiler. The hottest and lightest portion of the water will be at the top of the boiler, and for this reason the flow-pipe is there inserted. The heated water will follow in the direction of

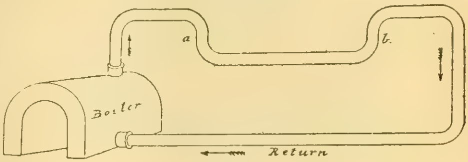



Fig. 2.

the arrows, in the flow-pipe, but as it travels along some of its heat will be lost by conduction and radiation, and as it gets further and further from the boiler it will become less and less hot, and consequently more and more dense, so that the water in the return pipe will be heavier, bulk for bulk, than the water in the flow-pipe. There is, in fact, an unequal pressure in the up and down pipes, and it is this inequality of pressure which causes the continual circulation on which the efficiency of the apparatus depends. With

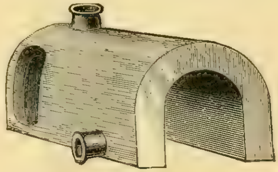


Fig. 5.

these facts before us, it will be seen that it is quite a mistake to suppose that it assists the circulation to give the return pipe a considerable fall, as shown in dotted lines in Fig. 1. The water would then have a shorter distance to travel, so that it would not lose so much heat, and consequently the difference in temperature of the water in the boiler and in the return pipe would be less, and the circulation would be impaired.

In practice there is seldom any great difference in the

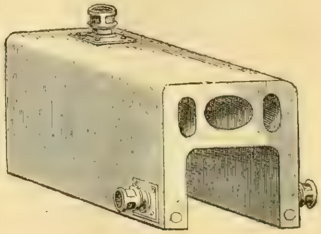


Fig. 6.

temperature of the boiler and the return—usually it does not exceed 20° F.—and as the circulation of the water depends on this difference of temperature, it will be understood how extremely small is the power available for doing the work. It is, in fact, of the greatest importance to avoid everything tending to check or interfere with the flow of the water, as very little will suffice to stop it altogether. Care should be taken to avoid unnecessary dips in the piping, especially such as are shown in Fig 2. They not only cause increased friction, but owing to the density of the water being increased as it travels further from the boiler, it follows that the column of water *b* will be denser

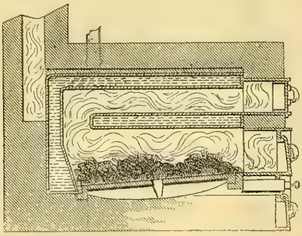


Fig. 7.

and heavier than *a*, and consequently have a tendency to make the water flow back to the boiler, from *b* to *a*, instead of from *a* to *b*. It is often necessary to dip the pipes under doorways and other structural obstacles, but this should be avoided as much as possible. There are also cases in which

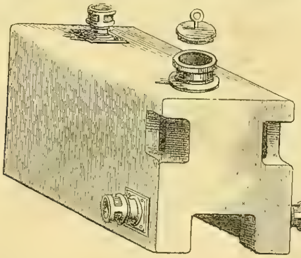


Fig. 8.

it is necessary to dip part of the piping below the level of the bottom of the boiler, and when provision of this kind has to be made it will be best to carry up the vertical flow pipe to a higher level, as the longer the ascending and

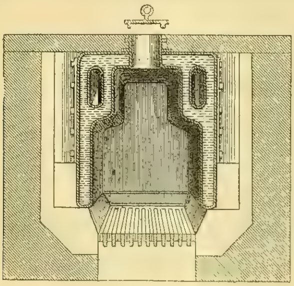


Fig. 9.

descending pipes are respectively, the greater will be the difference in the temperature of the water they contain, and the greater will be the inequality of the pressure. This will increase the power of circulation, and assist the flow through the pipes which are below the level of the boiler. It is also important that air vents should be provided in all positions where it is probable that air will accumulate. Air being much lighter than water, the vents should be made in the tops of the pipes, and if not self-acting they should be opened frequently, for if air be allowed to accumulate it will greatly impede, and may altogether stop, the

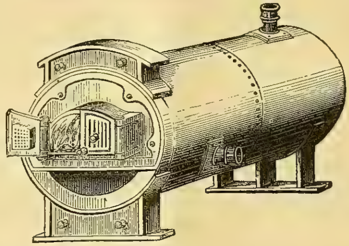


Fig. 10.

circulation of the water. When the boiler and pipes are first charged with water care should be taken to drive off the air, but this will not suffice. Cold water holds air in solution in greater quantity than does hot water, and when the water put into the boiler is heated, much of the air leaves the boiler and rises to the highest points it can reach

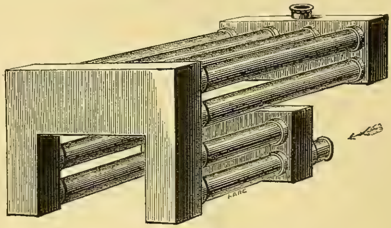


Fig. 11.

in the pipes; at these points there should be vents. So far as the circulation is concerned, it can be relied on for any height to which it is practicable to carry up a column of water. The practical limit will be one of construction, for, as is well known, the pressure of water on each square inch increases about half a pound for every foot of vertical

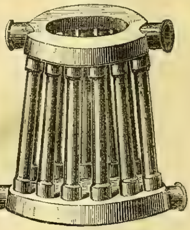


Fig. 12.

height. In the usual way of heating a glass-house the pipes are very little above the boiler, and the system is essentially a low-pressure one. Where the pipes are required at higher levels, it is simply a question of rightly proportioning the strength of the boiler and pipes, and of having good joints. Unlike steam, hot water has very little expansive force, and where no steam is generated an explosion is impossible; if the circulation be right, the worst that can happen will be a leakage of water due to the cracking of the boiler or pipes. It is, however, right to add that if the circulation is impeded, the water in the boiler may be overheated, and steam with its attendant risks will be produced.

Having dwelt on the importance of securing an unimpeded circulation of the water, we will now pass on to consider some points connected with the boilers generally

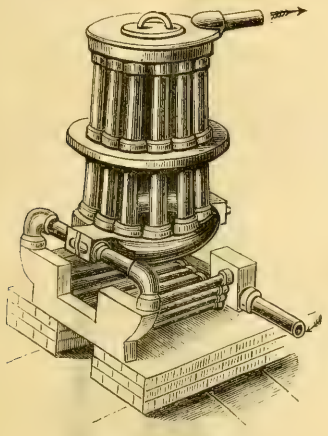


Fig. 13.

used for heating the water. The variety of boilers made for this class of work is very great, but it will be sufficient for our purpose to consider only some typical examples, and these we give in the accompanying illustrations.* Fig. 3 is a wrought-iron rivetted boiler of the saddle type. Fig. 4 is similar in form, but the joints are welded together without rivets; and Fig. 5 is also similar in form, but made of cast-iron. These boilers have the merit of being simple in construction, and can be heated with any kind of

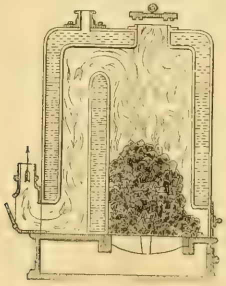


Fig. 14.

fuel, but they have not as large a heating surface as Figs. 6 and 8, the sections of which are shown in Figs. 7 and 9. Fig. 8 is arranged so that the fuel may be put in at the top, and this is an advantage in some cases. Both these boilers are decidedly good from an economical point of view, as there is a free and rapid circulation of water, which means a rapid withdrawal of heat from the fire. Fig. 10 is a modified form of the well-known Cornish boiler, so much used for producing steam. Fig. 11 is a boiler consisting of horizontal tubes, and Fig. 12 is one with vertical tubes. Both heat the water rapidly, but in our opinion are less efficient than Figs. 6 and 8. Fig. 13 is a development of Fig. 12, and is much used. All these boilers have to be set in brickwork, with suitable flues; but there is another class called independent boilers, which are self-contained, and need no brickwork. Of these, Figs. 14 and 15 are good examples, as the heating surface is large, while the construction is simple, and the circulation of the water is rapid. In Figs. 16 and 17 we have an independent boiler of considerable merit and originality. It consists of several sections placed one above the other, and to a certain extent the power of the boiler may be increased or diminished by adding to or reducing the number of sections.

We have already seen that the circulation of hot water depends mainly on the difference of temperature in the flow and return pipes; it is, therefore, important not only that the boiler should heat the water quickly, but that the heated water should be able to leave the boiler without check. Also, it is not desirable that the boiler should contain a large quantity of water, as within certain limits the smaller the quantity of water the more rapidly it will be

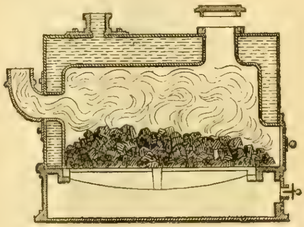


Fig. 15.

heated, and the quicker will be its movement and circulation. The boiler is always full of water, and there is little or no danger of any part of it being overheated if well designed, and if kept free from lime and other deposits inside. A wrought-iron boiler heats water more quickly than one of cast-iron, as the metal is thinner, but cast-iron is now extensively used, as it is not only cheaper but corrodes more slowly. On the other hand, it requires more careful stoking, especially when the fire is started, as it is unable to bear severe strains of expansion or contraction. It is also important to remember, as a general rule, that the heating surfaces of a boiler are more effective when they are horizontal than when they are vertical, and this consideration is especially important when a large boiler is required. Care should also be taken to have space enough in the boiler to contain the fuel required for several hours' work.

In selecting a boiler for a given amount of work, it should be borne in mind that the design of the boiler should to a certain extent depend on the amount of heating it is required to do. For instance, such a boiler as shown in Fig. 10 is more suited to a long length of piping than a short length; on the other hand, Figs. 14 and 15 are designed for moderate lengths of piping. The following table, however, will assist the reader to compare the relative heating power of the different boilers illustrated, as from data guaranteed by the makers we have given the number of feet run of pipe, 4 inches diameter, which each boiler is capable of heating under like conditions of temperature:—

* We are indebted to the Thames Bank Iron Company for the illustrations of Figs. 3 to 12, and 14 and 15; to Messrs. Weeks and Co. for Fig. 13, and to Mr. James Keith for Figs. 16 and 17.

*Table I. showing the number of feet run of pipe,* 4 *inches diameter, which each boiler is estimated to heat.*

| No. of Fig. | Length of Boiler. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 18 in. | 21 in. | 24 in. | 30 in. | 36 in. | 42 in. | 48 in. | 54 in. | 60 in. |
| 3 | 200 | 250 | 300 | 400 | 550 | 700 | 850 | 1,000 | 1,200 |
| 4 | 150 | 200 | 250 | 325 | 425 | 550 | 650 | 800 | 900 |
| 5 | ... | ... | 325 | 450 | 550 | 750 | 950 | 1,200 | 1,400 |
| 6 | ... | ... | 400 | 600 | 800 | 1,000 | 1,200 | 1,400 | 1,700 |
| 8 | ... | ... | 500 | 650 | 800 | 1,000 | 1,250 | 1,500 | 1,800 |
| 10 | ... | ... | ... | ... | 500 | 600 | 750 | 900 | 1,100 |
| 14 | ... | ... | 350 | 450 | 550 | 650 | 750 | 850 | 1,000 |
| 15 | 150 | ... | 250 | 350 | 450 | 550 | 650 | ... | ... |
| 11 | 6 ft. long = 1,250; 9 ft. 6 in. = 1,750; 14 ft. long = 2,500. | | | | | | | | |
| 12 | 250, 350, 500, 750, 1,000, according to size. | | | | | | | | |
| 13 | 750. | | | | | | | | |
| 16 | With 4 sections, 500; 5 sections, 650; 6 sections, 800; 7 sections, 900. | | | | | | | | |

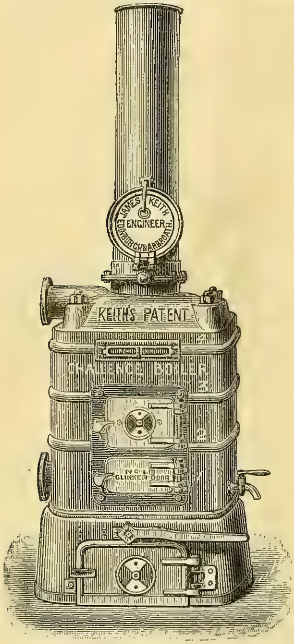



Fig. 16.

According to Mr. C. Hood, F.R.S.,* experiments have shown that the water contained in an iron pipe of 4 inches diameter internally, and $4\frac{1}{2}$ inches externally, loses ·851 of a degree (F.) of heat per minute, when its temperature is 125° above that of the surrounding air. Therefore, one foot in length of pipe 4 inches internal diameter will heat 222 cubic feet of air one degree per minute, when the difference between the temperature of the pipe and the air is 125°. Taking this as a basis, we then have the following rule for determining the length in feet run of iron piping required for heating a given volume of air. *Rule:* Multiply the volume of air in cubic feet to be warmed *per minute* by the difference between the maximum temperature required in the room and the temperature of the external air; then divide this product by the difference between the proposed temperature of the room and of the pipes; and finally multiply this result by 1·12 for pipes 2 inches diameter, by ·75 for pipes 3 inches diameter, and by ·56 for pipes 4 inches diameter. For example, if 200 cubic feet of air are to be warmed per minute, if the difference between the internal temperature required and the external temperature is 30° F., and if the difference between the proposed temperature of the room and of the pipes is 90°, we shall then have

$$\frac{200 \text{ c. ft.} \times 30^\circ}{90^\circ} = 66{\cdot}6 \text{ to be multiplied}$$

by 1·12 for pipes 2 ins. diameter $= 74\frac{1}{2}$ feet run.
" ·75 " 3 " $= 50$ "
" ·56 " 4 " $= 37\frac{1}{3}$ "

For ordinary purposes it will, however, be sufficiently accurate to take the figures given in Table II., in which will be found the approximate lengths of piping required for every 1000 cubic feet of space to be heated.


Fig. 17.

*Table II. showing the approximate lengths of piping* 2, 3, *and* 4 *inches diameter required for every* 1000 *cubic feet of space to be heated.*

| Description of Buildings. | Temperature required. | Pipe 2 ins. diameter. | Pipe 3 ins. diameter. | Pipe 4 ins. diameter. |
|---|---|---|---|---|
| Churches and large public rooms | 55° F. | 14 ft. run | 9 ft. run | 7 ft. run |
| Schools and lecture-rooms | 58° " | 14 " | 9 " | 7 " |
| Dwelling-rooms | 65° " | 24 " | 16 " | 12 " |
| Halls, shops, waiting-rooms, etc. | 60° " | 20 " | 13 " | 10 " |
| Workrooms, manufactories, etc. | 55° " | 12 " | 8 " | 6 " |
| Drying-rooms for wet linen (when empty) | 180° " | 360 " | 240 " | 180 " |
| Drying-rooms for paper, leather, etc. | 70° " | 40 " | 27 " | 20 " |
| Greenhouses and conservatories | 55° " | 70 " | 47 " | 35 " |
| Graperies and stove-houses | 70° " | 90 " | 60 " | 45 " |
| Pineries, hot-houses, etc. | 80° " | 110 " | 73 " | 55 " |
| Dairies, etc. | 56° " | 36 " | 24 " | 18 " |

It may be mentioned that pipes 4 inches diameter are best for horticultural purposes, but that smaller pipes are generally better for other work.

(*To be continued.*)

* "A Practical Treatise on Warming Buildings, etc.," by Charles Hood, F.R.S. E. and F. N. Spon, London.

## A NEW INDUSTRY IN SKYE.

AT the present time when people are at their wits' end to know what to do with the crofters in Skye, it is very fortunate that a means has been discovered of giving them some useful employment. In the small Loch Quire, a diatom deposit of exceptionally rich quality has been lately found. Diatoms are plants of minute size and beautiful form, consisting of one cell. They propagate very rapidly, as many as a thousand millions being formed from one parent cell in a single month. Their skeleton is an indestructible pair of transparent plates of a kind of flint. For centuries these shells have accumulated, forming vast beds in different parts of the world. The city of Richmond, in Virginia, is built upon an extensive deposit of this nature, which extends over many square miles of area. The purest and best descriptions have hitherto been found in Germany, and are used in the manufacture of ultramarine. This brilliant colour, which was formerly very scarce and expensive, used to be obtained from the mineral lapis-lazuli, a volcanic product, indestructible by fire.

For the manufacture of ultramarine, purity is most essential in the diatomite, and nowhere has the deposit been found of greater purity than this in Skye. It contains no less than eighty-nine per cent. of flint, and, after calcination, is almost pure flint. Operations have already been commenced by the Laird of Kilmuir with the view to working this lucky find. Some idea may be formed of the value of this deposit, when we mention that in Germany alone the manufacture of ultramarine exceeds 8000 tons a year, realising more than a quarter of a million sterling. There will doubtless be no difficulty in selling the produce of a rich deposit suitable for this fine purpose, and even the coarser parts will be of use in the manufacture of dynamite, polishing powder, glaze for pottery, filtering apparatus, and emery substances. Being an excellent non-conductor, it is found exceedingly useful in the coating of steam-pipes and chimneys, safes, and retorts, in the lining of ice-cellars and chambers for preserving meat. Such a discovery has just come at the right time. It may become even more remunerative to proprietors and workmen than was the manufacture of kelp in the beginning of the century, when Lord Macdonald realised £20,000 of annual gross income from that source alone. It is to be earnestly hoped, then, that this industry will succeed, especially when the crofters have no remunerative labour, and the landlords are nearly rentless.

WOOD PULP.—A writer in a Canadian paper, speaking of the possibilities of pulp as a substitute for wood in the manufacture of furniture and other articles, calls attention to the resources afforded by northern Canada for the best pulp-making woods. By mixing the pulp with clay, steatite, asbestos, plumbago, mica, etc., substances of every possible colour and compactness may be produced. The value of wood-pulp for paper-making has long been recognised in Canada, and it is hoped that a considerable revenue may, through this source, be derived from forest trees otherwise valueless.

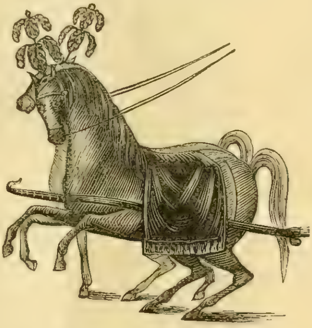
SOAP-BUBBLE BALLOONS.—M. Delon, of Paris, produces miniature balloons by means of ordinary gas conducted through a caoutchouc tube and clay-pipe to glycerine soap solution. A small disc of thin paper, with fine wire from its centre to a little paper car with aeronaut figures, is connected to the bubble when it begins to swell, the disc being attached by capillarity to the part where the drop forms. The detached bubble rises with the car.

## TECHNICAL JOURNALISM FIFTY YEARS AGO.

THE present is the Jubilee year of the reign of Her Most Gracious Majesty the Queen—a statement for which we claim no originality—and all loyal Britons would do well to make a retrospect of the progress that has been achieved, since Her Majesty came to the throne, in that particular subject with which they are most intimately connected. In our own special province, that of applied science, the advance has been really stupendous: another remark which our readers may justly consider not altogether original.

It would be ridiculous for us to attempt to give, within the space at our command, even the briefest sketch of the work of these fifty Victorian years in the whole field of science; but the chance perusal of an old volume has suggested the idea that we may be able to say something, we hope of interest, on the narrower question of scientific, or technical, journalism. The book referred to consists of a twelvemonth's numbers of the *Mechanics' Magazine*, beginning with No. 713, which was issued on the 8th of April, 1837; for the *Magazine* year did not correspond with that of the almanac.

Those who remember this publication at the date referred to—and how much smaller their numbers are becoming year by year—will call to mind a small octavo pamphlet of sixteen pages. The title-page was always graced by a wood engraving, generally a rude representation of some mechanical device, although occasionally pretence was made to artistic effect. We reproduce, for the benefit of a younger generation, a drawing of the horse of the period from the *Magazine* draughtsman's point of view. In the original it was attached to "Croft's hearse and mourning coach combined"—an invention for which a great future appears to have been expected. We spare our readers the vehicle (with the coffin duly shown in position) as inappropriate to this year of rejoicing.



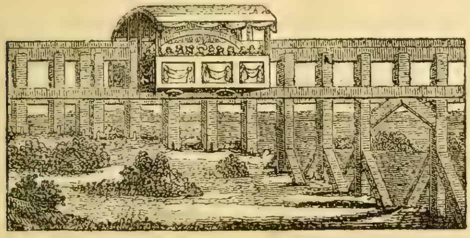
The *Mechanics' Magazine* was retailed for the sum of three pence, and for many years was in sole possession of the field in its own particular line. The quality of the paper itself would now be considered of the poorest kind, for it was rough and ill-coloured; but it possessed that virtue of toughness which many of our more sightly modern productions so sadly lack. From the literary point of view there is one feature that now strikes the reader immediately, and that is the very large proportion that correspondence bears to the whole matter. Those were golden days for proprietors and editors alike, upon which we, in these degenerate times of brisk competition, can only look back to with unavailing regret. There is no department of a paper more easy to edit than the correspondence columns. The simple statement that "We are not responsible for the opinions advanced by our correspondents" relieves the editorial staff of a world of anxiety, and in the days of which we are speaking the existing libel laws did not exercise their restraining influence, and make publishers, printers, and proprietors alike never safe. This fact is evident from the nature of much of the correspondence. "The lie direct" was far more frequent than the "retort courteous;" and correspondents seem to have measured the value of their communications by the amount of vituperation they could introduce into them, strengthened by all the emphasis of italics or large capitals, which the editor always considerately allowed. A good example of this literary cudgel play is to be found in the correspondence that arose on the question whether Sir Humphrey Davy was, or was not, expelled from the presidency of the Royal Society. Mr. John Herapath took the affirmative view, and is roundly abused by the friends of Sir Humphrey through a good part of the volume; "insolent puppy" being one of the mildest terms by which Mr. Herapath's opponents would consent to designate him.

question, all the rest that was not correspondence having been reprinted from other sources.

Another railway, that seems now almost as natural an adjunct to London as the old Birmingham Railway has since become, was then exercising men's minds and imaginations. Brighton was, in 1837, but a germ of what it has since become. There were, it is true, green verandahs in the King's Road; and on the beach in front of this thoroughfare were hauled up those homely fishing luggers, the genuine old Sussex hog-boats, which are now fast becoming extinct. The Pavilion, of course, had existed for many years, and the Chain Pier had become a familiar sight. Even the concrete cliffs at Kemp Town were in a rudimentary state; but the vast congeries of houses at the north and west was uncommenced. Hove was a distinct village across the fields, as much so as Southwick now is, and had not been smothered by the rows of terraces and squares, or the wilderness of brick and stucco which now sprawls its unlovely length to the confines of Portslade. Still, comparatively unimportant and pleasant as Brighton then was, four or five rival schemes were in the field for connecting it with the metropolis. Robert Stephenson wished to reach it by way of Shoreham, "availing himself of the vallies (*sic*) of the Mole and Adur," Sir John Rennie would go direct, whilst Mr. Gibbs would have worked the Greenwich Railway into his scheme. Great George Street was not then the power it has since become, neither had the Board of Trade spread its organization over all railwaydom. A military engineer, Captain Robert Alderson, was appointed to consider the matter and report to Her Majesty's Principal Secretary of State for the Home Department. This martial censor appears to have favoured Stephenson's plan, and his reasons for and against the various schemes are fully set forth in his report, which may still be read in the issue of the *Mechanics' Magazine* for July 8th, 1837. In this same number there is a reprint from the *Morning Herald*, reporting the partial opening of the Grand Junction Railway between Birmingham and Liverpool and Manchester. There were at that time plans for seventy-five


Turning over the faded yellow pages of this half-century-old volume we are reminded how recent, after all, are many of those events whose origin must appear to the younger members of this generation of the most respectable antiquity. Can a business-man of forty years old, who perhaps has a branch establishment in Liverpool or Manchester, realise that only ten years before he was born that ponderous façade at Euston Square did not exist? Yet on the first page of this 1837 volume there is a wood-cut of the vast tomb-like structure as it was then about to be. "We are happy to see," says the enthusiastic editor, "that the Birmingham Railway is so far approaching a completion, that the works of a grand façade for the entrance at the London terminus have been commenced. The view on our front page is from a beautiful lithograph by Chiffins, and if the erection does not disappoint the hopes held out by the design, it will certainly be the grandest elevation of the kind in the metropolis." The description of this "Grecian Doric Portico in antis," occupying about twenty full-page lines, was the only editorial matter in the number in proposed railways lodged in the Private Bill Office, and forty-eight were under the consideration of Parliament; but no railway had crossed the borders of either Scotland or Wales.

The problem of using steam-carriages on common roads was then still a burning question, although perhaps it had excited more interest at a previous time. It was a feature round which raged much of the vigorous correspondence distinctive of the *Magazine*, rival inventors slinging vituperative ink with a freedom from restraint that must have been very easeful to their feelings when experiments went wrong. In the year Her Majesty succeeded to the throne there were "three or four new productions" of this nature on Vauxhall Bridge Road and the Finchley Road. "In mercy to the inventors," says a correspondent of that date, who himself had laboured in the same field, "I



will not mention names, having seen their performances, which, like so many others, bring common road steam-locomotion into utter contempt." The two best-known names amongst the designers of steam-carriages were Hancock and Gurney. The engraving below, also taken from the pages of the *Mechanics' Magazine*, gives an illustration of the former inventor's design. It was built in 1836, and at the time the picture was published had run twenty weeks continuously on the Stratford, Islington, and Paddington roads. During this time it covered about 4,200 miles, and carried 12,761 passengers. The general rate of travelling was 12 to 15 miles an hour, but 21 miles had been reached with 20 passengers on board. For five weeks this wonderful apparatus might have been seen at the Bank twice a day. The cost for fuel was said to have been 2½d. per mile. The cylinders were 12 inches in diameter. The boiler was perhaps the chief feature of interest. It was composed of flat plates bolted together with alternate flue and water spaces. A short time ago, during a discussion on torpedo-boat boilers, at the Institution of Civil Engineers, Sir Frederick Bramwell referred to the "Hancock" boiler, and advised torpedo boat-builders to turn their attention to it, as likely to afford better results than the loco-marine type now in use for these vessels.

Before leaving the subject of locomotion we should like to give one more example of an invention of fifty years ago. The annexed engraving is another reproduction from the *Mechanics' Magazine* of 1837. It represents "Uri Emmon's Patent Improved Single Rail Railroad." The carrying wheels are placed, it will be seen, near the roof, the carriage being slung on each side, much as a donkey's panniers are balanced across the animal's back. To prevent the whole apparatus tilting or jamming against the railway, two horizontal guide wheels are attached to the bottom of the carriage on each side, and these revolve against suitable guides on the way. We give this illustration because a device somewhat similar has been resuscitated within the last few months, and a company has been formed to construct railways acting on this general principle, with steam engines, however, to supply motive power. In fact, the arrangement is one of those which has been re-invented again and again any time within the last fifty years.

Both our space and our readers' patience are limited, otherwise we might be tempted to fill many columns with the wonderful inventions that were the result of that sanguine age. The majority of these have not survived, even if they ever reached to the dignity of practical realization. One enthusiast proposes to obtain motive power by means of a vast circular building, which is to be rotated by animals walking, or, rather, attempting to walk, inside. Another ponderous invention, which was dignified with the full-page illustration of the issue, was a balance canal lock, in which the whole structure pivoted in the centre and swung up to admit the barge as if it were a huge mouse-trap. Yet another inventor proposed to make the rails for railways hollow, so they might be used as speaking-tubes. There were numerous inventions relating to paddle wheels. One is worth notice. It was suggested that the paddle-wheels should be planked all over so as to be buoyant. This, the genius who suggested the idea remarked, would stop the ship from rolling in a heavy sea; but he does not give any suggestions as to the length of main bearings. A gunpowder engine is also illustrated. It was considered to offer great promise in the matter of economy. Further on there is a rotary engine, the drawing of which might easily be mistaken for that of some forms quite recently patented. Another invention found in this volume, which is worthy of attention, is the "sea gauge" of Dr. Hales. It consisted of a bent tube, like an inverted syphon, containing mercury. One leg was hermetically sealed, and on the surface of the mercury at that end there is a film of treacle; the other end was left open. Upon the apparatus being lowered into the ocean the increasing pressure would compress the air in the enclosed end, and the treacle, smearing the tube, would enable an estimate to be formed of the depth reached by the apparatus. This device of fifty years ago, the illustration of which we reproduce below, is interesting, as it contains the germ of the idea which has since been brought to greater perfection by Sir William Thomson.

Amongst inventions described in this book which have lived and prospered may be found the fire-escape, Bunnett's revolving iron shutters, Massey's patent log, and outside surface condensers for steam-boats. The latter is a device which has of late years been successfully applied, more especially in America and the Colonies. Whitworth's screw stock and a revolving gun are illustrated as novelties, whilst the failure at certain gas-works is attributed to the use of fire-clay retorts. Velocipedes are also mentioned, and although the modern bicycle was then unknown, the tricycle was represented by a machine similar in principle. Some of our present-day flyers of the wheel will read with amusement the following paragraph taken from a letter inserted in the *Mechanics' Magazine* of August 26th, 1837:—"I should feel much obliged," wrote "A Constant Reader," "if yourself or one of your talented correspondents would explain what is the rationale of the velocipede. . . . . . . . Can a man employ his muscular power to effect a greater velocity than walking or running, by mechanical interventions, without a proportionate exhaustion, or has nature placed a limit that

no ingenuity can pass?" As no "talented correspondent" came forward to answer this question, we will, after this lapse of fifty years, take on ourselves to do so. On a bicycle, one mile has been ridden in a trifle less than two minutes and forty seconds, and five miles have been covered in fourteen minutes and twenty-two seconds. Fifty miles have been covered in two hours forty-seven minutes and thirty-six seconds. Within the space of a single day (24 hours) one rider urged his machine over 295 miles of road. Turning to tricycles we find that fifty miles have been ridden on the high road in three hours and nine minutes, and one hundred miles in a little under eight hours and a half. These, we believe, are not the best records in cycle riding, but they will serve to answer "Constant Reader's" inquiry. Let us hope he is not beyond the possibility of profiting by our replies.

With these few figures we may fittingly conclude; for perhaps nothing could be produced to illustrate the progress of industrial science more conclusively than the modern cycle.

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## NOTES ON COLOUR.

### II.

THERE is a popular idea that "complementary" colours are to be explained by the red-blue-yellow theory, which contains an error already pointed out in the first series of these notes. It is said that red is a complementary colour to green, because green is a mixture of the other two colours; and blue is complementary to orange, because orange is a mixture of yellow and red.

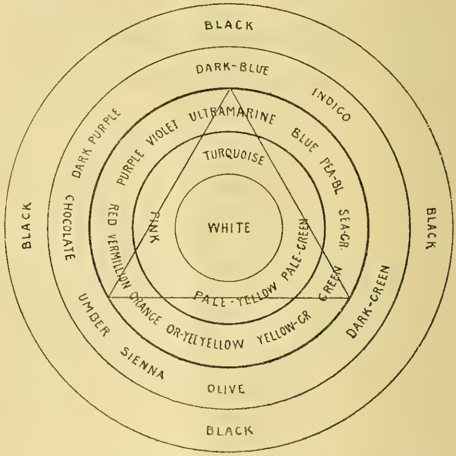
This ingenious idea has doubtless been of as good service to those whose business lies in the use and arrangement of colours, as the still prevalent three-colour theory alluded to above; and each has the merit of leading to tolerably correct results up to a certain point.

The true definition is that two colours are said to be complementary when the result of their mixture is white. To mix paints is, as was described last month, merely to *subtract* the colours, the resulting tint being produced by the survival of those which the paints have in common. One of the simplest methods, and one to which accurate measurements can be readily applied, is that of revolving discs. Two or more colours can be combined in any desired proportions by painting cardboard discs, which are slit radially from the centre to the circumference, so that they can be mounted on the same axis, and then set in rapid rotation. A drill, provided with a pair of bevel wheels, which can be obtained for a shilling or two, is very convenient for this purpose. Discs painted with gamboge and cobalt will give a pure white when mixed in the proper proportion. Many paints, on account of their impurity, will at the most give a neutral grey.

The study of many colour problems is facilitated by the use of colour diagrams or charts. The diagram given here would, if coloured, exhibit all tints except those containing grey.

The strong circles enclose the pure simple colours—violet, ultramarine, blue, peacock blue, sea-green, green, yellow green, yellow, orange yellow, orange, vermilion, red, purple. The complementary colours are diametrically opposite, and white is at the centre. An inner circle contains tints which are mixtures with white—lilac, turquoise, pale green and yellow, and pink. The outer circle shows mixtures with black. The blues and greens when mixed with black do not alter their nature much, but appear darker; indigo is identical with a mixture of Prussian blue and black. The greens do not much alter their nature, but may be described as dark green. True sage green contains white as well as black, and should not appear in this diagram. Yellow with black gives olive, and orange and red give the various browns. A more complete chart might be arranged by taking the circle of pure colours and their mixtures with white, and a series of similar diagrams, each containing an additional quantity of black, and piling these on the top of each other, forming a column; or successive leaves to a book. The centre of this column would contain all the pure greys, ending with white at the top and black at the bottom. The pure browns would be directly under the pure orange and red, while coffee colour, which is whitish, would be nearer the centre.

The diagram has other uses than the indication of the complementary colours. The three colours of Young's theory may be represented on it at the corners of a triangle, as has been done in what is known as Maxwell's diagram. Neglecting the two outer circles, which are given merely for the purpose of showing the browns and other combinations with black, the result of any mixture of two or more colours will be found at a point between them, whose distance from the colours depends on the proportion in which they are mixed. For example, equal parts of vermilion and emerald green give a pale yellow, and a mixture of ver-




milion and ultramarine gives lilac, and violet with sea-green gives pale blue; while violet, orange, and sea-green together will make a light pink. These mixtures are at once accounted for by the theory of the three sets of nerves or processes of sensation.

The true mixture of colours, as distinguished from the mixing of paints is a matter of importance in textile manufactures composed of coloured threads. The result of a number of parallel threads, seen at a distance, is a true mixture of their colours. The effects were studied by Chevreul, when he was appointed director of the Gobelins Dye Works. The colours were not generally brilliant enough to produce white, but a mixture of complementary tints gave grey. The beautiful grey tints of a distant landscape are due to the mixing of innumerable colours, and the pearly effect of a Cashmere shawl is greatly due to the small points of bright colours, which produce a richer appearance than a simple tint of grey, because, except at a considerable distance, the mixture is not quite complete.

Another use to which the colour chart may be put is to predict the effect of the contrast of colours. If a piece of scarlet cloth and a piece of violet cloth be placed side by side in a good light, the scarlet will appear more orange and the violet more blue than they really are. If they are separated the effect is destroyed, and they appear in their natural tints. Each, in fact, is changed as though it had been tinged with the complementary colours of the other. The result is more apparent to those who have not a well-trained eye for colour, when one of the tints is grey and the other a brilliant hue; and the effect is even more striking when a piece of tissue paper or muslin is laid over them. A grey pattern on a green ground appears of a rose tint, and the same is seen even with a black pattern. Chevreul relates how one of the first paper-hanging manufacturers of Paris wished to print grey patterns on grounds of apple green and of rose, and that he refused to believe that his colour preparer had given any grey paint to the printer because the designs printed on these grounds appeared coloured with the respective complementaries. He also narrated that a dispute arose between certain drapers and a calico-printer, to whom red, violet, and blue cloths had been sent, with orders to print a black pattern thereon. When they were delivered it was complained that the patterns on the red cloths were of a green colour, upon the violet a yellowish green, and on the blue they were of a rusty brown colour, instead of black. Chevreul was able to demonstrate, both by showing the patterns through holes in white paper, and by cuttings of black cloth, that the supposed fault was purely subjective, and that there was no ground for complaint. The patterns would have appeared to be more black had they been tinged with the colour of the ground. The same law of contrast affects the artist, and if he is forewarned may save him a considerable amount of work. For example, the warm light from windows consisting chiefly of glass with yellow patterns fills a church with a warm glow, and daylight coming in through upper windows of clear glass has a bluish tint. An artist who truthfully represented this on a picture and took blue paint to represent the apparently blue light, will give his picture an exaggerated effect. A painter generally works up his picture by degrees to avoid such mistakes, and where, as in water-colour painting, the sky is sometimes put in first, a strong colour in the landscape will spoil the sky tints which have been put in, and make them appear false and thin. Hence the practice of many landscape painters of covering their blank canvas with the dominant tone of the scene before proceeding to finish. A green background to a portrait painted in low cold tones gives it a warmer tint, and the spectral redness added to the greyer colour of the picture will sometimes give a singular effect, but the quality of the green is important. A yellowish green, as will be seen in the diagram, will give a purplish red, and a bluish green will give a more orange effect. At the same time green is a difficult colour to use, especially in large surfaces, unless it is considerably broken up. Rosy flesh tints with grey shadows will often give the shadows a greenish tinge, as already described. No green exists actually, but it is not uncommon, though not always pleasing, to find green paint actually used in figure painting for flesh shadows; they have, of course, the reflex effect of heightening somewhat the warmer colours.

The law of contrast may be employed to determine the best colour for a background for any special purpose. Silver work, for example, should be displayed in such a way that there should be no suspicion of orange or yellow about it, since this would suggest tarnish. The opposite of yellow and orange is violet and blue, and to give a spectral violet or blue the rule would point out the use of a yellow or orange background; but it is necessary also to heighten the whiteness of the silver, so the colour should at the same time be dark. A rich brown or deep orange will, therefore, have this effect. Green or red will have no ill effect, for the complementary colours are purple and green. Gold, on the other hand, looks well on a blue or violet ground, and would be "killed" with yellow; that is to say, using the rule of contrast, it would be tinged with the complementary to yellow, namely, violet; and violet and orange make whitish pink, which would spoil the gold. A grey-green ground has an excellent effect on gold. Red and gold, it is true, form a rich combination pleasing to the eye; but the point here is that it is somewhat to the disadvantage of the gold, as gold.

No one has yet succeeded in giving a definite rule or set of rules for making pleasing combinations of colours, nor has any satisfactory theory yet been given for showing why any two colours make a pleasant or an unpleasant effect. Brücke, Rood, Chevreul, Field, and Owen Jones have written on the subject. It is unfortunate that many writers accepted the red-yellow-blue theory, although this did not prevent the construction of such colour diagrams as the present one. Rood points out that a line drawn from violet to yellow-green divides the diagram into warm colours and cool colours, and he suggest that colours which are less than about ninety degrees or a right angle apart, generally form an unpleasant combination. Good combinations are said to be always more than ninety degs. distant. Colours differing by small intervals, however, often form good pairs, as yellow and orange, but the reds are very apt to "swear" at each other.

## EARTHQUAKES AND THEIR CAUSES.

THE successive calamities of Krakatoa, Ischia, Granada, Charleston, and now of the Riviera, have latterly directed public attention, in the most painful manner, to earthquakes, and to the many unsolved problems which they involve. The mere surface phenomena of these, and of similar events, have been dwelt upon most abundantly. But concerning the causes at work, there still prevails no little uncertainty. This want of exact knowledge is the more to be regretted, since it affects not merely the *savant* in his study, but the general public in its daily life. Until we succeed in working out a plain, definite theory of these fearful visitations, we shall never know when and where to expect their approach, and can consequently neither regulate our movements nor modify our domestic architecture to meet the necessities of the case.

Unfortunately, those very points which are most needed for the proof or the disproof of any given theory have been, until about forty years ago, overlooked as unimportant. At that time Mr. Robert Mallet took up the scientific study of earthquakes, to which many geologists, physicists, and engineers have since made valuable contributions. Previously, historians, chroniclers, and philosophers had enlarged on the numbers of the maimed or the slain, on the overthrow of single buildings or of entire cities, and on the destitution and—in too many cases—the pestilence which succeeded. But they could tell us little, or nothing definite, concerning the direction and the number of the shocks, or their character as lateral, upwards, oscillatory, or even rotatory or whirlpool-like—the most dangerous of all. Another important feature is the speed at which the disturbance is propagated, as measured by the time when a shock is felt at different localities. This velocity has on different occasions been estimated at from 2,000 to 12,000 feet per second, according to the character of the strata traversed. In certain cases a shock may be propagated through the soil more rapidly than sound can traverse the air. Thus, in the great gun-cotton explosion at Stowmarket, in August, 1871, the windows of buildings situated about a mile from the magazine, and facing in the opposite direction, were seen to fall out of their frames *before* the noise of the detonation reached the spectators.

The extent of the region shaken is also of great moment, as throwing a light upon the seat of the centre of action. If a shock be felt simultaneously, or nearly so, in places hundreds of miles apart, we know that its source must be very deep. The great Lisbon earthquake in the last century is supposed to have agitated one-eleventh part of the earth's surface. That of Krakatoa was probably felt at least over as great an extent. That of Charleston affected a land-area of 774,000 square miles, and probably at least half as much more of ocean-area. The *epi-centre*, that is, the point supposed to be exactly above the source of the shock, is not by any means the part most severely shaken.

In earthquakes which are localised within narrow limits, the disturbance is often near the surface. Thus, in an earthquake of no great intensity or extent, which occurred a few years ago in a coal-mining district in the north of France, not the slightest agitation was felt in the workings, whilst on the surface of the earth buildings were shaken, and movable objects displaced. Indeed, the number and extent of mining accidents connected with earthquakes is by no means great. We might have naturally expected that in Chili, Peru, Mexico, etc., the mines must often collapse upon the unfortunate workers. But such does not seem to be the case.

The first crude attempt to explain the phenomena of earthquakes took its stand on their supposed connection with volcanic eruptions. It was suggested that vast volumes of gases and vapours were generated in the interior of the earth and sought for free escape. Where such vent was found the result was a volcano; where there was no outlet, earthquakes ensued. It was even asserted that where mines were numerous they allowed of an escape for the gases, and thus served as safety-valves. In support of the volcano theory, it was shown that Asia Minor, Syria, the Greek Islands, Spain, Portugal, northern Italy, and the eastern side of North America, have no active volcanoes, and have at all times suffered more or less severely from earthquakes. But, on the other hand, there are many regions studded with volcanoes, and yet fearfully liable to subterranean shocks. Southern Italy, Sicily, the west coast of South America, Iceland, the Sunda Islands, and Japan, all conspire to prove that volcanoes at least do not prove efficient safety-valves for the excessive pressure. Very closely connected with this theory is another view which pays particular attention to the fact that both volcanic and seismic action haunt especially the sea-coasts. We have no authentic records of either eruptions or earthquakes of any importance in the vast plain which extends through northern Germany, Russia, and northern Asia. The interior of Africa and the great river-valleys and alluvial plains of eastern South America seem free from both these scourges.

Hence it is contended that the cause—or, at least, one of the causes—of earthquakes must be the water of the sea finding its way into the interior of the earth, and there coming in contact with matter which may effect its decomposition or its evaporation. Here we have at least two possible cases. It is familiarly known that the alkaline metals, such as potassium and sodium, have the power of decomposing water, combining with its oxygen and setting its hydrogen at liberty. If there exist, as was suggested by Sir H. Davy, considerable underground deposits of any of these metals the access of water would determine a convulsion which, according to local circumstances, will take the form of an earthquake or of a volcanic eruption.

But another case is open. Suppose the water of the sea finds sudden access to intensely-heated strata, whether these be liquid or solid. An immediate liberation of steam on an immense scale would be the necessary result. Those who are familiar with steam-explosions will best appreciate the probable results if millions of gallons of water are thus flashed into vapour. It is further known that if water falls upon an intensely heated surface it does not at once evaporate, but remains in the so-called spheroidal condition until the temperature is sufficiently reduced, when it evaporates with explosive violence.

We are far from contending that ordinary earthquakes are thus occasioned. But from a variety of circumstances which cannot here be given in detail, the fearful and altogether exceptional catastrophe of Krakatoa was probably thus produced. That chemical reactions do play a part in the phenomena of volcanoes and of earthquakes will appear from the fact that hydrochloric, hydrosulphuric, and sulphurous acids, all in the gaseous state, have been given off as well from chasms in the earth as from the craters of volcanoes. But on this point much further investigation is needed.

Not a few scientific men have contended that earthquakes are, in many cases at least, the outcome of electric action. This view is advocated in *Blackwood's Magazine* for July, 1869; in the *Quarterly Review* for July, 1881; and in the *Journal of Science* for December, 1883, and for January, 1884. The writer of the two last-mentioned articles, Colonel Arthur Parnell, R.E., gives the particulars of 490 earthquakes, of which 437 were accompanied by thunderstorms, magnetic disturbances, or other meteorological phenomena generally considered to be causally connected with electric action. He writes that:—"It is now well established that in India, at all events, earthquakes are almost always accompanied by furious storms of thunder." On the other hand, a correspondent of the same journal, who has experienced six earthquakes in India, states that they were unattended by thunder, lightning, or rain, or, in fact, by any atmospheric disturbance whatever.

The late Cromwell Varley—certainly no mean authority—was of opinion that some earthquakes at least are due to subterranean electric discharges. But if we find that earthquakes are generally preceded, accompanied, and followed by electric disturbances we have still to ask which of the two classes of phenomena is cause, and which effect. We may even first raise the question whether the relation between the two is anything more than a coincidence. Certain it is, at least, that thunderstorms of the severest character may be, and often are, unaccompanied by earthquakes. This may be observed in the Transvaal, and indeed generally in the interior of Africa—a region at once singularly liable to electric tempests, and as singularly exempt from earthquakes. But before any satisfactory decision on the electric character of earthquakes can be reached it will be necessary to make, in some country where shocks are frequent, such as Japan, prolonged series of electric and magnetic determinations.

The alleged periodicity of earthquakes must not be left unconsidered. Mallet considered that there was a maximum about the middle of each century, and a second, but less marked maximum, towards the end. He held also that earthquakes were most prevalent about the time of the winter solstice. Now, if we consider that our centuries are purely artificial periods, having, so far as we know, no reference to a connection with any recurrent natural phenomena, we shall find it hard to admit that their middles can be thus signalized. Concerning the late earthquake at Charleston it is noticed in the *Bulletin of the Washington Philosophical Society* that it coincided with an unusually high tide; that the moon was near perigee, and there had been an eclipse of the sun only three days previously. This brings us to another theory, viz:—that the particular times of earthquakes are determined by the position of the heavenly bodies, especially of the sun and moon. If we assume, with certain geologists and physicists, that the interior of the earth is in a fluid state, resembling lava, we can readily conceive that the movements of the heavenly bodies would occasion in this molten mass a kind of tides. Were the sun and moon alone concerned, the phenomena of earthquakes would be repeated at regular intervals. An eminent French physicist has maintained, however, that the gravitation of the superior planets—especially Jupiter and Saturn—comes also into play. The case must thus be greatly complicated, and a long time must elapse before the theory can be established, or refuted, by actual observation.

Let us here remark that if we go on the other hypothesis, of the solidity of the earth's interior, as held, *e.g.*, by Sir W. Thomson and Professor G. Darwin, the gravitative action of the heavenly bodies is by no means excluded.

Another theory, which seeks for the exciting cause of earthquakes outside our own globe, is that of the sun-spot cycle. Every eleven years or thereabouts the spots on the sun's disc pass from a maximum to a minimum, and not a few authorities hold that this cycle may be traced out in the character of the weather, in the abundance or scarcity of the crops, in the appearance of flights of locusts, in public health, in commercial crises, and even in wars and political agitations. Hence its application to earthquakes is not surprising. It cannot, however, be readily made to tally with recorded facts. The number of earthquakes is found to be far greater than was formerly suspected, no fewer than 104 having been recorded in the year 1876. From 1881 to the present date no year has passed unmarked by at any rate one earthquake of considerable extent and intensity. We do not see how this annual recurrence is to be reconciled with an eleven years' cycle.

The favourite theory at present is that of the progressive cooling and consequent shrinkage of the earth's crust. That such a process of refrigeration is at work cannot be doubted, and that when acting upon bodies of different conducting powers, such as the strata of the earth, it must produce unequal contractions is also fairly certain. Lateral shocks, the opening of chinks and fissures, and movements of translation may thus be satisfactorily explained. Nor need we, if we accept this theory, wonder why earthquakes should occur in some regions of our globe more than in others. But whether it can, without overstraining, account for all the phenomena of earthquakes, especially those of an eruptive and projective character, may well be questioned.

We conceive, in short, that under the common name of earthquake there are included phenomena, alike in their destructive action upon life and property, but different in their origins. Some, it will probably be found, are due to refrigeration and shrinkage; some, like that of Martinique, to electric action; some, such as at Krakatoa, to the infiltration of water: and some, perhaps, to a gradual dissolving out of soluble matter in certain strata, thus approximating the result to a landslip.

This subject has a very practical side. In Granada, as in Charleston, it has been remarked that upon certain strata the ruin was much greater than upon others. It lies within human power to determine what localities are the most dangerous and which are comparatively safe.

Further, the Japanese have for ages built their dwellings of light wood, so that, in case of an overthrow, the loss is trifling and the danger is minimized. Europeans and their descendants have in the meantime gone on erecting in the earthquake districts ponderous dwellings, palaces, and churches of massive stone-work, and have again and again been crushed by their own handiwork.

Lastly, an earthquake-country can prosper only by agriculture. If it enters upon a manufacturing career, any day may see its total ruin. What would be the issue of a single first-rate earthquake in England?

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## THE PATENT OFFICE.

THE report of the committee appointed by the Board of Trade to inquire into "The Duties, Organisation, and Arrangements of the Patent Office under the Patents, Designs, and Trade Marks Act, 1883, having special regard to the system of examination of the specifications which accompany applications for patents, now in force under that Act," is now issued, and will be perused with interest by the large body of persons who are connected with, or take a special interest in, the working of the patent laws in England. The Patents, Designs, and Trade Marks Act of 1883 made no alteration in the fundamental laws ruling the grant of letters patent, but only in the procedure and routine to be adopted in the examination of the specifications and the granting of the patent. It is clearly of the greatest importance that such procedure and routine shall be of the simplest, most effective, and least costly description, and this report of the committee gives some useful and instructive information on this point.

The committee was first appointed on December 30th, 1885, and reconstituted on March 3rd, 1886. It consisted, from the latter date, of Lord Herschell (then Lord Chancellor), the Earl of Crawford, Baron Henry de Worms, M.P., Sir Bernhard Samuelson, M.P., Sir Richard Webster, Q.C., M.P., and Mr. C. T. D. Acland, M.P. It was therefore about as strong a committee as could have been got together for the purpose, and as the members have been engaged in the interval in taking evidence and preparing this report, it may be considered to represent their full and matured opinions.

The committee appear to have devoted almost the whole of their attention to the question of examination of applications, which constitutes one of the great changes introduced by the Act, and the one about which there has been most complaint and difference of opinion. Their recommendation upon this subject is: "That sub-sections 5 and 6, of section 7, and the corresponding provision in section 2, should be repealed." These two sub-sections refer to the examiner reporting to the comptroller when he finds that any particular specification passing through the office comprises the same invention as some other specification also passing through the office at the same time, and to the comptroller giving notice to both applicants that their specifications interfere with each other. The reference to this in section 2 is to the effect that such notice may be cited as one of the grounds upon which a patent may be opposed. The report states that this system has failed to effect its purpose, and that the cost of carrying it out has been from £3,000 to £4,000 a year.

We are hardly disposed to form so low an estimate as the committee do of the success of this system. Our experience would lead us to conclude that when the notice has been unsatisfactory or incorrect, the applicants have generally ignored it altogether. On the other hand, when it has been well founded, some sensible working arrangement has usually been made between the parties interested. In cases where opposition has resulted, it has generally ended in the offending parts of the specification of more recent date being struck out. This is a course naturally involving far smaller expense to the parties than would have been the case had the patent been completed and legal proceedings been taken.

Those evils which have been complained of really arise, and this is practically admitted in the report, through the practice which so many competent judges for a long time past have regarded as a mistaken one—and against which one influential witness spoke strongly in his evidence before this very committee—of issuing notices of interference upon provisional specifications. The report, as we have said, practically acknowledges this evil, but adds : "We do not think it has arisen from any want of care in the office, but from the nature of the work to be done. Two provisional specifications may disclose apparently the same invention, and yet, when the complete specifications are received, it may appear from the fuller and more precise descriptions embodied in them that there are really two distinct inventions, each properly the subject-matter of a patent."

If the notices referred to were issued only upon complete specifications, very few, if any, mistakes need be made. The reason is obvious. In a provisional specification the very details, which in many cases are essential to the proper understanding of the invention, are intentionally omitted, while in complete specifications these details are minutely specified.

It would appear then that if the practice of issuing notices of interference upon provisional specifications were stopped, the evil would, if not entirely, at least, to a very large extent, be remedied, without mutilating the Act in the manner proposed by the committee.

There is, however, another aspect of this examination and interference question which must not be lost sight of. Without the interference element the whole system of examination is like the play of *Hamlet* with the Prince of Denmark left out. Take away the notices of interferences and what have we left? Let the Act speak for itself. Section 6 says the examiner "shall ascertain and report to the comptroller whether the nature of the invention has been fairly described, and the application, specification, and drawings, (if any) have been prepared in the prescribed manner, and the title sufficiently indicates the subject-matter of the invention." Section 9 states that when a complete specification is left after a provisional the examiner shall ascertain whether the complete specification has been prepared in the prescribed manner, and whether the invention therein set forth is substantially the same as that described in the provisional specification. Briefly, the examiner shall see if the provisional specification is in order (which can be done by rapidly glancing through it), and also if the complete specification is in order, and fairly agrees with the provisional. But what security or advantage is such an examination to the inventor in whose interest it is supposed to be made? Will such an examination as this tell him that his invention has been patented before in the years gone by, or even that there is a precisely similar application passing through the office at the same moment as his? Assuredly not; it will simply cost him and his fellow tax-payers something like £1 per application, for which they will fail to find the least useful return. The number of applications for patents last year was 17,162, and the cost in salaries alone of the examination was, we are assured, not less than £20,000, and most probably it was more. The report states that the interference department costs £3,000 to £4,000 per annum, so it is fair to take the cost of the bald and useless examination described above at £1 per application, and as a very large number of the applications are never completed (last year, we believe, it was about 40 per cent.) a considerable part of that sum is for examining provisional specifications only. Attention has been repeatedly drawn to the fact that under the old law of 1852, at the time of its supercession by the Act of 1883, there were, roughly speaking, 6,000 applications, and these were successfully dealt with by two men, who, however, did not examine the complete specifications. There are now only a little more than three times that number of applications, and yet (not counting the interference examination, and the staff of ten assistant examiners which, the report says, are employed upon it) we are asked to believe that an examining staff of some sixty men is necessary to cope with them at the enormous outlay mentioned above.

Surely, in this matter of examination, the committee has failed to establish its case; it has either gone too far in proposing to abolish interferences—and we contend it has gone too far—or it has not gone far enough; and, in abolishing interferences, has abolished also a system of examination which, stripped of its most valuable feature, is at once useless and expensive.

The report makes a useful recommendation in proposing that the time to be allowed for making amendments ordered by the office should, except in special cases, be limited to one month; considerable abuse is believed to have arisen under the present conditions where no limit is set, as an applicant taking the full time allowed (sometimes reaching to eight months), may avail himself of information obtained from later applications in which the complete specification has been filed with, or soon after, the application. Lastly, the report recommends that a roll of patent agents should be established, and, if this suggestion be adopted, that a fresh committee should be appointed after sufficient time has elapsed to test the new arrangements.

And is this all? Has this important committee, specially appointed to inquire into the duties, organisation, and arrangements of the Patent Office, nothing to say upon any of these heads? Has it no recommendation to make whereby some of the present expenditure and redtapeism may be avoided? Not a single word!

A year ago the condition of affairs at the Patent Office had become so notorious that the Board of Trade itself appointed the strongest Committee probably that ever sat for such a purpose, to inquire into the duties, organisation, and arrangements of that office; and the result of their labours is—— that they recommend an alteration in the system of examination! Not a word about the duties of those responsible for the proper working of the office! Never a word about the organisation or arrangements of the staff! Does this ignoring of the real business for which they were called together mean that the committee found the organisation of the Patent Office so perfect that they could not suggest any improvements? or does it simply mean that the whole arrangements were so hopelessly bad that any useful alteration would have to be of so sweeping a nature that they dare not recommened it?

Exception is likely to be taken by some of the witnesses to the amount of "editing," to which their evidence appears to have been subjected before being printed in this report, and, perhaps, a similar description of censorship may account for the singular lack of useful information relating to the internal economy of the Patent Office.

## REVIEWS OF BOOKS.

*Practical Electricity.* By Prof. W. E. Ayrton, F.R.S. London: Cassell and Co.

Students of electricity of the present day may be congratulated on having this book to assist them in their studies. It supplies what has long been wanted—namely, a clearly-written text-book on the subject of electricity which is quantitative without being mathematical; or, rather, without the abuse of mathematics. Electricians of the old school have become more and more conscious that the system under which they studied—if, indeed, it could be called a system—and the books and experiments from which they gained their knowledge were lacking in one important particular. They obtained general ideas on their subject, and they laid down a foundation of broad and ill-defined principles, but they had no definite and exact quantitative knowledge. If they wished to construct apparatus, or to carry out experiments, they knew what they should do in an approximate sort of way, and as they went on they modified their apparatus or plan of experiment as they found it necessary. And very good results have been, and may be, obtained in this way, but better work, and more of it may be done by having a correct insight into, and perception of, the values of the electrical units. And this book, more than any of its class which has ever been published, will enable students to attain to this very desirable clearness of perception. The method adopted is the natural one of conducting the learner to perceive, by experiment and trial, the real meaning and value of electrical phenomena. In his preface, the author justifies his mode of procedure by the following remarks :—

"It is not by studying geometrical optics, much less physical optics, that an infant gradually learns to appreciate the distance of objects; and, later on, it is not by studying a treatise on struts, nor by listening to a course of lectures on structures, that the child finds out that the table has legs, hard legs, round legs. Feeling, looking, trying, in fact, a simple course of experimental investigation gives a child its knowledge; and this, therefore, I venture to think, is the method we should adopt when commencing the study of electricity."

This book is a boon to teachers of, and students in, science and technological classes; and perhaps in a still greater degree, to the very great number of solitary students who cannot fail to find that it will reduce to a minimum those knotty and obscure points which are, perhaps in electricity more than in any other subject, such a bugbear to the unassisted learner.

*First Year of Knowledge.* By Paul Bert, Member of the French Institute, Professor at the Sorbonne, Ex-Minister of Public Instruction. Translated by Mme. Paul Bert. London: Relfe Bros.

This is a charming little book, and should be in the hands of all instructors of young children. It is one of the results of the ever-increasing effort to make the gaining of knowledge pleasant and easy; and most completely does it effect its object.

As its name implies, the book is intended for beginners; but instead of being a succession of dry statements, set down in a matter-of-fact manner—such as would have been the case had it been produced twenty or thirty years ago—the child is insensibly led on by the author's clear and pleasant manner until he has acquired a fair knowledge of the rudiments of Natural History, Physics, Chemistry, and Physiology, which are the subjects chiefly treated.

There are a large number of small but well-executed illustrations, which form a most attractive feature in the book.

Elderly and middle-aged people are apt to speak of their school days as the happiest time of their lives. If this were true, with the crabbed methods of teaching of times past, how much greater will be the happiness of our children who have all these delightful books, and knowledge brought to them in so pleasant a guise?

*Railway Problems: An Inquiry into the Economic Conditions, of Railway Working in Different Countries.* By J. S. Jeans: Author of "England's Supremacy," etc., etc. London Longmans, Green and Co. 1887.

Having gone through this latest work of Mr. Jeans, we are at a loss whether to look on it as a book of reference, or one for general reading. On a cursory examination of its pages we were inclined to the former view, and the very large number of calculations, amounting to many thousands in all, upon which it is founded, would, in the ordinary course, have confirmed this estimate. Mr. Jeans, however, is one of that rare class, a statist, who can clothe his dry facts with interest, without, at the same time, sacrificing anything of their substantial value.

The first chapter is "Historical and Retrospective," and in it the author goes back to the time, "still within the memory of living men," when the first ton of merchandise was drawn, and the first passenger conveyed by the first locomotive used on a public railroad. It is but little more, he says, than the "allotted span" since there was but one stage-coach between London and Edinburgh. It started once a month from each of these cities, and took a fortnight to complete the journey. The charge for wagon-hire from Leeds to London was thirteen pounds a ton, and to transport goods from Liverpool to Manchester cost forty shillings a ton.

Such statements as these afford an admirable introduction to the book, and give the formal columns of figures Mr. Jeans has sometimes to use, a dramatic interest they would not otherwise possess.

The second chapter deals with the important question of "Railway Capital"; after which the no less interesting subject of "Cost of Railway Construction" is attacked. Leaving the chapters which deal with other branches of the financial aspect of railways, we find the author discoursing on such practical questions as "Locomotive Power," "Economy of Fuel," "Expenditure on Permanent Way," "Rolling Stock," and other subjects of this nature. American railways and Colonial railways have each a chapter to themselves. The latter had partly appeared in the form of a paper read at the Colonial and Indian Exhibition last year. Some collateral subjects are introduced, such as "The Extent of Internal Commerce," the "Cost of Labour," and the work terminates with a valuable appendix, containing a very full chronology of railway events in the United Kingdom.

It can hardly be expected that, in a work containing such a vast array of facts and figures as that under consideration, some errors have not crept in; but we must leave it to sharper eyes than ours to discover them. It may, however, we think, be safely surmised that with an experienced and accomplished statist, such as Mr. Jeans is known to be, such errors, if they exist at all, will be remarkably rare.

## THE ROYAL INSTITUTION.

PROFESSOR MAX MULLER gave, on the 17th of March, at the Royal Institution, the first of a course of three successive Thursday afternoon lectures on "The Science of Thought." To all present was given a copy of the preface of the lecturer's forthcoming book upon the same subject. The lecturer referred at the outset of his prelection to former courses which he had given there, especially on the science of language, dating as far back as a quarter of a century. He began by explaining what at that early epoch was the meaning of comparative philology, which was then quite an unknown quantity, even to a highly cultivated audience like those wont to listen to Faraday and Young, but which was now fairly well known as an integral branch of classical learning, and which it was well understood was not to be confounded with the science of language. The former was the means, the latter the end. Much progress had been made of late in the study of the phonetic, grammatical, and syntactical structure of language, but there was still much work to be done. At the same time the science of language had a higher purpose—namely, to discover the secrets of thought in the labyrinth of languages, and more particularly to explain the reaction of language on thought which was what was comprehended under the general name of mythology. The science of language, in fact, was a telescope for watching the movements of our thoughts, and a microscope to discover the primary cells in which our concepts lay hidden. Language was formerly deemed so complicated and wonderful that it seemed impossible to ascribe to it a merely human origin. No doubt the wealth of language was very vast. English had been shown to comprise a quarter of a million words, and even the comparatively infantile prattle of the inhabitants of Tierra del Fuego claimed more than 32,000 words. This showed how wrong a view Darwin took of the intellectual capacities of the lowest of all savages, while at the same time it reflected the highest credit on the philosopher that, as the lecturer showed by reading an extract from a letter addressed by that great man to himself, he at last owned his mistake. But though the wealth of words was apparently so great, the stream could be traced back to a few rivulets of elements, partly material and partly formal. The natural elements of language, or the so-called predicative roots, had been reduced to about 800, and the formal or demonstrative elements to about three score. With these elements everything existing in human speech could be accounted for. Roots must fulfil three conditions. They must be intelligible, not only to the speaker, but to all who listened to him; they must be embodied in a definite number of consonants and vowels; lastly, they must express general concepts. These three conditions were fulfilled if, with Noiré, we accepted a root as the *clamor concomitans* of primitive acts performed by peoples in common. Roots received their conceptional character from the fact that primitive men were more conscious of their acts as the same, though slightly changed and repeated again and again. This was the first historical step leading towards a concept, or a comprehension of many things as one. The 800 roots, however, had been reduced to a much smaller number of concepts—namely, 120—and with these 120 concepts and a few demonstrative elements the whole of our language could be accounted for. As the 72 chemical elements of the universe accounted for the whole of nature, so these 120 elements, by being combined again and again, explained the whole of our language and the whole of our thought. Whatever we think, we think by means of 120 fundamental concepts, or possibly with even fewer.

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A DISCOURSE at this institution was given last month by Captain W. de W. Abney, R.E., the subject being "Sunlight Colours." The facts brought forward were, the lecturer said, the result of experiments conducted conjointly with General Festing, R.E. An important point to be recognised was that different people had very different powers of appreciating colours. What was called roughly colour blindness had long been known, but a more delicate test had been tried on a large number of people, including many distinguished artists. The colours of the spectrum were taken in succession, and tested for the recognition of the intensity with which each colour was seen. Few could recognise equally throughout, and those whose perceptive powers were good for the red end failed in a large percentage in the blue, and *vice versa.* Half of the artists could only see three-fourths of the red. Professor Tyndall's now well-known theory of the "scattering of light by fine particles" was referred to as producing the distant blues in what artists called atmospheric effects. But there was another effect of fine particles which was illustrated in several ways. One of the most striking of these was with a turbid solution of mastic, gradually becoming more turbid. In alcohol mastic was soluble, in water it was not. A beam of light was first shown passed through a clear alcohol solution of it, and through a prism which split it up into a spectrum band. The addition of water to the solution caused fine particles to form, increasing in number, and hence increasing the turbidity of the solution. As this proceeded it was seen that the spectrum commenced to vanish at the blue end, gradually disappearing to the red, which was the last portion left. This was exactly what was obtained in some sunsets when the air was misty; the sunlight from the yellow portion of the spectrum being gradually cut off, till the orange, and then only the red, rays were left. An artificial sunset on this principle was shown most satisfactorily. A number of photographs were also shown, taken at different altitudes in Alpine regions, and exhibiting how "atmospheric effects" lessened as the dryer air was reached.

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## THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 15th of March, a paper was read on "The Treatment of Gun-Steel," by Col. Eardley Maitland, R.A., the Superintendent of the Royal Gun-Factory, Woolwich.

It was stated that gun-steel as used in England, and practically by two other gun-making nations (France and Germany), was a ductile material, a test-specimen of which broke under tensile strain at about 30 tons per square inch in the soft or annealed state, and at about 45 tons per square inch when hardened by being plunged, at a temperature of 1,450° F., into a bath of cool oil. It contained from 0·25 to 0·5 per cent. of carbon, and from 0·8 to 0·05 per cent. of manganese. The author proceeded to describe in detail the successive steps by which he had sought to estimate the value of oil-hardening. From a comparison of thousands of results he had formed the opinion that, taking the breaking-strain after oil-hardening as the datum, the limit of elasticity in the unhardened state rose with the proportion of manganese; and that the effect of hardening in oil increased with the proportion of carbon, raising both the elastic limit and the breaking-strain more than in the case of steel with a higher proportion of manganese. The condition of strain, however, of pieces tested in the machine differed from that experienced by the metal when built up and used as a gun. For example, when the copper cylinder of a crusher-gauge was repeatedly subjected to the same slowly-applied motion in a machine, no change was produced after the first trials; but if the cylinder were compressed to the same extent by a falling weight, or blow, subsequent equal blows compressed it still further at each trial. If two gauges were put into the chamber of a gun, and ten rounds fired with a suitable charge, one gauge being left untouched, but the copper cylinder of the other gauge being changed after each round, it would be found that the gauge which withstood ten rounds would simply indicate the highest pressure attained as recorded by the gauge which had been adjusted each time. If, however, an unsuitable charge had been used, and had set up a violent dynamic, or "wave," action, the gauge which had withstood ten rounds would indicate a higher pressure than that of any single round. Hence there was a certain resemblance between the action of suitable powder and the pressure in the machine. It had been noticed that in cases of bursting, the fracture, whether the gun were of cast-iron, or wrought-iron, or of steel, was invariably short and granular. It was formerly assumed in explanation of this that the slow pull of the machine did not at all represent the sudden strain put on the material when used as a gun. In order to test the truth of this assumption, a test-specimen was screwed into blocks, one above and one below, so that the whole falling a short distance, the top block was arrested, and the weight of the lower one subjected the specimen to sudden tensile-strain. The result of several experiments was that the elongation, instead of being about 27 per cent., as was expected, was about 47 per cent. This unexpected result determined the author to try the result of explosives. A strong tube was prepared by being accurately bored and furnished in the middle with a radial vent and a radial crusher-gauge. Plugs of steel, fitting the bore of the tube, were screwed on to each end of a specimen; these plugs were passed into the tube, the annular space around the specimen being filled in some cases with quick-burning paper, and in others with gun-cotton, air-spaced. On the charges being exploded through the vent, the plugs were driven violently out of the tubes, in opposite directions, each carrying one-half of the specimen. The elongations under these tests varied from 47 per cent. to 62 per cent., the fracture in all cases being silky and fibrous. With the largest charges of gun-cotton tried, the specimens in several cases broke in two places, the central piece being cigar-shaped. The results of these, and of other trials with tube-shaped specimens, and with steels of soft, medium, and hard quality, had convinced the author that the remarkable shortness of fracture noticed when a gun burst was a false indication of the quality of the metal. The true indication would be obtained by putting together the pieces and measuring the stretch.

The subject of erosion of the bore had been engaging the attention of the officers of the Royal Gun-Factory, and a great number of experiments had been made to ascertain the qualites of steel best suited to resist it. The details would be found in a joint paper by the author and Sir Frederick Abel, in the *Journal of the Iron and Steel Institute*, October, 1886.

The author then described in detail the long series of experiments, given in the appendix to this paper, made with the view mainly of determining the tensile strength of specimens cut from ingots hardened in oil, and unhardened, with and across the grain, and submitted, in the ingot, to varying amounts of work. Judging from the behaviour of specimens, there appeared to be a decided benefit to the steel in oil-hardening and annealing, even though the annealing undid the hardening; and as every nation making great guns used the oil-hardening process, it must be assumed that there were strong reasons for its adoption. Nevertheless, with forgings of large size, the oil-hardening was far less active, and very far less uniform than with test-pieces; and it became a serious question whether the double process of hardening and annealing acted so beneficially on the steel as to compensate for the risks incurred in setting up internal strain.

In conclusion, the paper described the process of building up the complete gun by shrinking. The formulas used at the Royal Gun-Factory for this purpose were, in the author's opinion, thoroughly practical and trustworthy.

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## THE GEOLOGICAL SOCIETY OF LONDON.

ON the 18th of February last, Professor Judd, F.R.S., the President, presented the Wollaston Gold Medal to Mr. J. W. Hulke, F.R.S., and the balance of the proceeds of the Woollaston Donation Fund to Mr. B. N. Peach, F.G.S. To the Rev. E. B. Brodie, M.A., F.G.S., he presented the Murchison Medal, and the balance of the proceeds of the Murchison Geological Fund to Mr. R. Kidston, F G.S. (by deputy). The Lyell Medal was awarded to Mr. Samuel Allport, F.G.S. (by deputy), and the balance of the proceeds of the Lyell Geological Fund to the Rev. O. Fisher, M.A., F.G.S. The Bigsby Gold Medal was presented to Professor C. Lapworth, LL.D., F.G S. The President then read his Anniversary Address, in which, after congratulating the Society on its present condition and prospects, and referring to some of the more notable incidents in the history of Geological Science during the past year, he proceede d to discuss the past and present relations between Mineralogy and the Biological Sciences. After insisting that the supposed distinction between living and non-living matter was not a fundamental one, he maintained that minerals resemble animals in possessing definite organisation, and in going through regular cycles of change. He further pointed out that, in the course of its development, Mineralogy was now exactly following in the same line which had been already taken by Zoology and Botany. He expressed his conviction that Geology and Mineralogy were powerful for mutual help, and that the latter science, now passing from the classificatory stage, had a great future before it.

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## THE LONDON SANITARY PROTECTION ASSOCIATION.

THE sixth annual general meeting of this association was held on the 26th ult., at Adam-street, Adelphi, Lord Chelmsford in the chair. The chairman read the report of the council, which stated that during 1886 312 old members had left the association, but 406 new members had joined, which brought the total membership up to 1,144. The number of houses inspected by the engineers of the association during 1886 had been 398, 59 per cent. of which had been found more or less unsanitary. This was rather higher than the average percentage of the five previous years. The total number of houses inspected since the formation of the association was 2,210. In most of these the sanitary arrangements had been either rendered perfect or very much improved. The council had reason to believe that the improved sanitary state of these houses did not represent the whole benefit done by the association.

## RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.

*** *The whole of the papers of the Societies referred to are not included in this list.*

### THE ROYAL SOCIETY OF LONDON.

Mar. 3rd.—Papers read, "Studies on some new Micro-organisms obtained from Air," by Mr. G. C. Frankland and Dr. P. Frankland; "On the Limiting Distance of Speech by Telephone," by Mr. W. H. Preece, F.R.S.

Mar. 10th.—Papers read, "Note on Induction Coils or Transformers" and "Note on the Theory of the Alternate Current Dynamo," by Dr. Hopkinson, F.R.S.; "On the Transmission of Sunlight through the Earth's Atmosphere," by Capt. Abney, F.R.S.

Mar. 17th.—Papers read, "A Coal-dust Explosion," by Mr. W. Galloway; "Second Note on the Geometrical Construction of the Cell of the Honey Bee," by Prof. H. Hennessy, F.R.S.; "On the Total Solar Eclipse of Aug. 29th, 1886," (preliminary account) by Prof. Schuster, F.R.S.

### THE ROYAL INSTITUTION OF GREAT BRITAIN.

Jan. 21st.—Paper read, "The probable origin, the total amount, and the possible duration of the Sun's heat," by Sir Wm. Thomson, D.C.L., LL.D.

Feb. 4th.—Paper read, "Some Unpublished Records of the City of London," by Mr. E. Freshfield.

Feb. 18th.—Paper read, "Genesis of Elements," by Mr. Wm. Crookes, F.R.S.

Feb. 25th.—Paper read, "Sunlight Colours," by Capt. W. de W. Abney, R.E., F.R.S.

Mar. 25th.—Paper read, "Colour of Thin Plates," by Rt. Hon. Lord Rayleigh, M.A.

### THE SOCIETY OF ARTS.

Feb. 22.—Paper read, "Wrought Ironwork," by Mr. J. S. Gardner, F.G.S.

Feb. 23.—Paper read, "Recent Advances in Sewing Machinery," by Mr. J. W. Urquhart.

Feb. 25.—Paper read, "New Markets and Extension of Railways in India and Burmah," by Mr. H. S. Hallett, F.R.G.S.

Feb. 28.—Cantor Lecture, "Building Materials," by Mr. W. Y. Dent.

Mar. 1.—Paper read, "The Colonial and Indian Exhibition," by Mr. E. Cunliffe-Owen.

Mar. 2.—Paper read, "The Cultivation of Tobacco in England," by Mr. J. E. Beale.

Mar. 4.—Paper read, "Traffic Routes in the East," by Major-Gen. Sir F. J. Goldsmid.

Mar. 7.—Cantor Lecture, "Building Materials," by Mr. W. Y. Dent.

Mar. 9.—Paper read, "Railway Brakes," by Mr. W. P. Marshall.

Mar. 15.—Paper read, "The Application of Gems to the Art of the Goldsmith," by Mr. A. Phillips.

Mar. 16.—Paper read, "Machinery and Appliances Used upon the Stage," by Mr. P. Fitz-Gerald.

### ROYAL SCOTTISH SOCIETY OF ARTS.

Mar. 14.—Papers read, "Improvements in the Marine Compass and its Adjustments," by Mr. F. M. Moore; "On Micro-Photography," by Mr. W. Forgan.

### THE INSTITUTION OF CIVIL ENGINEERS.

Feb. 15.—Paper read, "Filter Presses for the Treatment of Sewage Sludge," by Mr. W. S. Crimp, C.E.

Mar. 1.—Paper read, "Dredging Operations and Appliances," by Mr. J. J. Webster, M.Inst.C.E.

Mar. 15.—Paper read, "The Treatment of Gun Steel," by Col. E. Maitland, R.A.

Mar. 24.—Paper read, "On the Resistance of Faults in Submarine Cables," by Mr. A. E. Kennelly.

STUDENTS' MEETINGS.

Mar. 4.—Paper read, "Propelling-Machinery of Modern War Ships," by Mr. S. A. Wells.

Mar. 18.—Papers read, "The Manufacture of Raw Sugar," by Mr. W. C. Kerr, Stud. Inst.C.E.; "The Process and Machinery of Sugar Refining," by Mr. L. Martineau, Stud. Inst.C.E.

### INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

Mar. 2.—Paper read, "Operating Railway Facing Points, Safety Bars, and Signals," by Mr. Angelo Fahie.

### SOCIETY OF ENGINEERS.

Mar. 7.—Paper read, "On Bridge Floors, their Design, Weight, and Cost," by Mr. E. Olander.

### UNIVERSITY COLLEGE ENGINEERING SOCIETY.

Mar. 2.—Paper read, "Modern Breech-Loading Guns," by Mr. R. J. Durley, Stud. Inst.C.E.

### JUNIOR ENGINEERING SOCIETY.

Feb. 25.—Paper read, "The Fallacies of Perpetual Motion," by Mr. W. J. Tennant.

### SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

Mar. 10.—Paper read, "On Reversible Lead Batteries, and their Use for Electric Lighting," by Mr. Desmond G. Fitzgerald.

### PHYSICAL SOCIETY.

Feb. 26.—Special General Meeting. Papers read, "Note on Prof. Carey Foster's Method of Measuring the Mutual Induction of Two Coils," by Mr. J. Swinburne; "On the Determination of Coefficients of Mutual Induction by Means of the Ballistric Galvanometer and Earth Conductor," by Mr. R. H. M. Bosanquet; "On the Continuous Transition from the Liquid to the Gaseous State of Matter at all Temperatures," by Prof. W. Ramsay and Dr. S. Young.

### THE COMPANY OF SHIPWRIGHTS.

Jan. 21.—Paper read, "Modern Warships," by W. H. White, Esq.

Feb. 2.—Paper read, "The Mercantile Marine and Foreign Competition," by A. D. Lewis, Esq.

### ROYAL UNITED SERVICE INSTITUTION.

Jan. 21.—Paper read, "Suggestions as to the Use of Machine Guns in the Field, in combination with Infantry," by Major A. D. Anderson, R.H.A.

Feb. 11.—Paper read, "Coast Defence by Gunboats," by Admiral Sir Geo. Elliott, K.C.B.

Feb. 25.—Paper read, "On Magazine and Repeating Arms," by Capt. W. H. James.

Mar. 11.—Paper read, "Mastless Men-of-War," by Capt. C. P. Fitzgerald, R.N.

### GEOLOGICAL SOCIETY.

Feb. 18.—Annual General Meeting.

Feb. 23.—Papers read, "On the Origin of Dry Chalk Valleys and of Coombe Rock," by Mr. C. Reid; "Probable Amount of Former Glaciation of Norway, as Demonstrated by the Present Condition of Rocks upon and near the Western Coast," by Mr. W. F. Stanley, F.G.S.

### ROYAL METEOROLOGICAL SOCIETY.

Mar. 16.—Papers read, "Notes on Taking Meteorological Observations on board Ship," by Capt. D. Wilson Barker; "Marine Temperature Observations," by Mr. Hugh R. Mill, F.R.S.E.

### SOCIETY OF CHEMICAL INDUSTRY.

Mar. 7.—Papers read, "M. Hermite's System of Electrolytic Bleaching," by Messrs. Cross and Bevan; "Castner's Sodium Process" and "A New Method of Elevating Liquids—especially applicable to Acids," by Mr. James Mactear.

### THE VICTORIA INSTITUTE.

Feb. 7.—Paper read, "On the Beauty of Nature," by the Right Hon. Lord Grimthorpe.

Feb. 21.—Paper read, "On Caves—their Age, Origin, and Age of Deposit," by Mr. T. McK. Hughes, F.G.S.

### THE BALLOON SOCIETY OF GREAT BRITAIN.

Mar. 11.—Lecture, "The Utilization of Petroleum," by Mr. J. Stringfellow, C.E.

### EDINBURGH PHOTOGRAPHIC SOCIETY.

Feb. 2.—Paper read, "Photographic Portraiture," by Mr. W. M. Crooke.

Mar. 2.—Paper read, "Demonstration of Gelatino-Bromide Paper Development," by Mr. F. Briglmen.

Exhibition of Plates of the Grand Observatory at Nice, by Professor C. Piazzi Smyth.

TRANSPARENT MOLTEN IRON.—*Engineering* says:—"Mr. W. Ramsay has observed that the molten iron, seen during a casting of several tons, is transparent. It was possible to see bodies through the stream of metal, they taking, however, a yellow tinge. The observation is one of much interest, and perhaps others engaged in the iron industry will be able to confirm it, since it is hardly likely that the phenomenon has not been witnessed before."

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

2910.—JOHN CLOUGH THRESH, 4, Mansfield Chambers, 17, St. Ann's Square, Manchester. "Manufacture of filtering materials." 25th Feb., 1886.

2915.—JOHN CRITCHLOW, THOMAS FORESTER, WILLIAM FORESTER, HERBERT FORESTER, and LEONARD FORESTER, Vulcan Works, Longport, Staffordshire. "Filter presses." 25th Feb., 1887.

2959.—HIPPOLYTE CHARLES CHOCQUEEL, 67, Strand, London, W.C. "Combined bell-push and automatic switch for electric alarms." 25th Feb., 1887.

2983.—GEORGE FREDERICK MARSHALL, 4, South Street, Finsbury, London. "Carbon for filtering and decolorizing purposes." 25th Feb., 1887.

3020.—ALFRED JULIUS BOULT, 323, High Holborn, London, W.C. A communication from Albert Newton Russell and Addison Brill, United States. "Magazine fire-arms." 26th Feb., 1887.

3077.—SAMUEL DENTON, 8, Quality Court, Chancery Lane, London. "Steam Engines." 28th Feb., 1887.

3081.—WILLIAM FORD STANLEY, Cumberlow, South Norwood, Surrey. "Clinometers." 28th Feb., 1887.

3087.—ERNEST WILSON, 9, Lavesstrasse, Hanover, Germany. "Dynamo-electric machines." 28th Feb., 1887.

3100.—PETER COOK, 96, Buchanan Street, Glasgow. "Papier-maché hollow vessels." 28th Feb., 1887.

3102.—JOHN COTTON, Town Hall Chambers, Bradford. "Diaphragm for mechanical or acoustic telephones." 28th Feb., 1887.

3117.—CHARLES GANNAWAY, 115, St. Vincent Street, Glasgow. "Shield for ventilators used on board ship, or in other situations." 1st March, 1887.

3123.—HERBERT JOHN ALLISON, 52, Chancery Lane, London. A communication from Laban Dennis and Thomas Laban Dennis, United States. "Steam engine cut-off and balanced valve for the same." 1st March, 1887.

3125.—WARREN DEARBORN HOUSE, 52, Chancery Lane, London. "Electrically transmitting speech and other sounds." 1st March, 1887.

3139.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Albert Sichel, United States. "Photography and photographic reproduction." 1st March, 1887.

3158.—PERCIVAL EVERITT, 4, South Street, Finsbury, London. "Giving Currents of Electricity on the insertion of a coin." 1st March, 1887.

3161.—FRANCIS OBRE FERGUSON, Gothic Cottage, Goldhawk Road, Hammersmith. "Spring bow dividers." 1st March, 1887.

3173.—SID HUGH NEALY and LEE HUTCHINS, 24, Southampton Buildings, London, W.C. "Marine torpedoes." (Complete specification.) 1st March, 1887.

3178.—JOHN EDWARD THORNTON, 3, New Lorne Street, Moss Side, Manchester. "Substitute for glass for photographic purposes." 2nd March, 1887.

3197.—SIR DAVID LIONEL SALOMONS, Baronet, THOMAS PARKER, and PAUL BEDFORD ELWELL, Wolverhampton. "Separating plates in secondary batteries." 2nd March, 1887.

3218.—JAMES HOLLOWAY, 204, High Holborn, W.C., and ALEXANDER BLACK, junior, 31, Alconbury Road, Upper Clapton. "Engines for steam, gas, or hydrocarbons." 2nd March, 1887.

3224.—HENRY EDWARD NEWTON, 6, Bream's Buildings, Chancery Lane, E.C. A communication from Edward Theisen, Germany. "Condensing apparatus." 2nd March, 1887.

3225.—ROBERT DICK and RANKIN KENNEDY, 96, Buchanan Street, Glasgow. "Generation and distribution of electric energy, and machines or appliances therefor." 2nd March, 1887.

3230.—TANGYES, Limited, and THOMAS JEFFERISS, 47, Lincoln's Inn Fields, W.C. "Portable boiler and centrifugal pumping engine." 2nd March, 1887.

3237.—HENRY HARRIS LAKE, 45, Southampton Buildings, W.C. A communication from George Vincent Fosbery, United States. "Magazine or repeating rifles." 2nd March, 1887.

3245.—HENRY JEPHSON, 91, Melbourne Street, Derby. "Fog signal Detonator." 2nd March, 1887.

3258.—RICHARD EDWARD DONOVAN, FRANCIS HAYLETT, and JAMES JOHNSTONE, 10, Leinster Street, Dublin. "Blowing glass by mechanical means." 3rd March, 1887.

3299.—GEORGE BAMBRIDGE MOSS, Alton House, The Close, Lincoln. "Ventilating apparatus." 4th March, 1887.

3322.—JOHN FORD, EDWARD FORD, and JEHU FORD, 128, Colmore Row, Birmingham. "Anchors." 4th March, 1887.

3323.—CHARLES LAKEMAN TWEEDALE, 4, Mansfield Chambers, 17, St. Ann's Square, Manchester. "Primary batteries." 4th March, 1887.

3325.—JOHN KERR, Britannia Engine Works, Kilmarnock. "Regulating the dilution of gas mixtures in three-cycle gas-engines." 4th March, 1887.

3335.—JOHN SMITH, 84, Tamworth Road, and ALFRED EMLEY, 44, Westgate Road, both in Newcastle-upon-Tyne. "Burners for regenerative gas-lighting apparatus." 4th March, 1887. (Complete specification.)

3340.—JOSEPH HARTLEY WICKSTEED, 323, High Holborn, Middlesex. "Arrangement of shearing machines for cutting hot blooms or cogged ingots." 4th March, 1887.

3341.—WILLIAM SPIERS FREEMAN and FREDERICK FREEMAN, 323, High Holborn, Middlesex. "Automatic weighing, measuring, and delivering machines." 4th March, 1887.

3342.—WILLIAM EDWARD AYRTON, City and Guilds of London Central Institution, Exhibition Road, London, and JOHN PERRY, City and Guilds of London Technical College, Finsbury. "Measuring the coefficients of self-induction, or of mutual induction." 4th March, 1887.

3346.—ILLIUS AUGUSTUS TIMMIS, 2, Great George Street, Westminster, S.W. "Lighting railway vehicles electrically." 4th March, 1887.

3362.—JOSEPH WILSON SWAN, 47, Lincoln's Inn Fields, W.C. "Detection of explosive gases in mines or other places." 4th March, 1887.

3405.—CHARLES GEORGE KNIGHT and JAMES THOMAS FORD, 12, Queen's Terrace, Kent Road, Southsea. "Dental suction valves." 5th March, 1887.

3414.—WILLIAM SNELGROVE, 166, Fleet Street, London. "Extinguisher mechanism for lamps." (Complete specification.) 5th March, 1887.

3417.—HENRY HARRIS LAKE, 45, Southampton Buildings, London. A communication from James H. Courier, United States. "Type-writing machines." 5th March, 1887. (Complete specification.)

3451.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Joseph Hanson, United States. "Rotary wire gigging machines." (Complete specification.) 7th March, 1887.

3469.—CHARLES AMBROSE MCEVOY, The London Ordnance Works, Bear Lane, Southwark, Surrey. "Electric primers and mechanism for firing breech-loading guns." 7th March, 1887.

3478.—JOHANN KLEISSL and ARTHUR DUFFEK, 34, Southampton Buildings, London, W.C. "Differential and other arc lamps." (Complete specification.) 7th March, 1887.

3530.—ALFRED JULIUS BOULT, 323, High Holborn, W.C. A communication from George Eastman, United States. "Sensitive photographic films." 8th March, 1887.

3531.—THOMAS SHAW, 323, High Holborn, W.C. "Testing gases drawn from mines." 8th March, 1887.

3542.—JAMES RETTIE, 27, Kirby Street, Hatton Garden, E.C. "Arithmometers." 8th March, 1887.

3551.—JOSEPH PANNELL GIBBINS, 28, Southampton Buildings, Chancery Lane, London. "Floating electro contact or automatic mine. (Complete specification.) 8th March, 1887.

3560.—EDWARD COOPER WARBURTON, 4, Mansfield Chambers, 17, St. Ann's Square, Manchester. "Holders and fittings for electric lamps." 9th March, 1887.

3605.—CHARLES SELDEN, 55 and 56, Chancery Lane, Middlesex. "Simultaneous telegraphy and telephony." 9th March, 1887.

3608.—JOSEPH DEVONPORT FINNEY ANDREWS, 28, Southampton Buildings, Chancery Lane, London. "Dynamo electric machines." 9th March, 1887.

3634.—CHARLES FREDERICK ARCHER, 166, Fleet Street, London. "Hydraulic lifts." 10th March, 1887.

3655.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Edward A. Williams, United States. "Ear trumpets." 10th March, 1887.

3673.—ALFRED VINCENT NEWTON, 6, Bream's Buildings, Chancery Lane, Middlesex. A communication from Alfred Nobel, France. "Projectiles." 10th March, 1887.

3675.—ALFRED VINCENT NEWTON, 6, Bream's Buildings, Chancery Lane Middlesex. "Explosive compounds." 10th March 1887.

# Scientific News

## FOR GENERAL READERS.

Vol. I.] May, 1887. [No. 3.

CONTENTS.



## CURRENT EVENTS.

Dr. Tyndall's Resignation.—A resignation of the Professorship of Natural Philosophy at the Royal Institution must necessarily be an important event to the members of the Institution and the world of science; but when the post has been filled so ably and for so long a period, as it has been by Dr. Tyndall, the fact becomes of considerable public importance. For thirty-four years Dr. Tyndall has carried out the duties of his office, and, to quote the resolution of the managers of the institution, "has rendered services which not only have upheld and have advanced the position of the Royal Institution, but have benefited science and the world at large." As Professor Tyndall absolutely declines to receive any pension, it has been determined to have a marble bust of him executed, to be placed in the Institution; in addition to which one of the annual courses of lectures is to be called "the Tyndall lectures." Dr. Tyndall is nominated Honorary Professor of Natural Philosophy, and Lord Rayleigh is nominated as his successor to the chair.

The Importance of Technical Education.—In the address just given by Sir Frederick Abel, at the Royal Institution, it was remarked that, notwithstanding the growth of the iron trade on the Continent and in the United States, and the great development in the use of steel, we have, fortunately, been able to maintain a leading position in the manufacture both of iron and steel. On the other hand, he pointed out that in another branch of industry, which had its origin in England, the lead has been taken by other countries. Coal is now the chief source of colouring matters, and, with her vast mineral supplies, England should have been *facile princeps* in this industry, but Germany has long outstripped us in the supply of materials we taught her chemists to make. Sir Frederick Abel attributes this, in some measure, to the defects in our patent laws, and to questions of wages and labour, but chiefly to the superior intellectual training of the German manufacturers and their technical assistants.

The German manufacturers have for some time realised that their success depends largely on the active prosecution of scientific research. They have employed chemists well trained in science, and they have specially encouraged scientific investigations tending to the improvement and development of their manufactures. "The young chemists," says Sir Frederick Abel, "whom the German manufacturer attracts to his works, rank much higher than ours in the general scientific training which is essential to the successful cultivation of the habit of theoretical and experimental research." These men come from the universities and technical colleges, where they have received a thoroughly scientific training, and they find in nearly every factory a research laboratory. They are thus well fitted in every way to study all new inventions bearing on the particular industry they are engaged upon, and seeing that the tendency of our day is for industry to be supported by a competition of intellect rather than by a competition of local advantages, as pointed out by Sir Lyon Playfair some time since, the importance of such a system cannot be overrated.

Manchester Jubilee Exhibition.—The Royal Jubilee Exhibition at Manchester bids fair to be one of exceptional interest, especially to the engineer and manufacturer, and others interested in the practical applications of science. It was to be expected that in so important a manufacturing centre there would be a good trade display, but the extent to which exhibitors of the best class have come forward has somewhat surprised even the authorities themselves. It is, however, fair to say that to some extent this is due to the business-like arrangements made by the Executive Committees. The mechanical section alone will have a really grand display of the latest developments of industrial machinery, and the planning of this section reflects the greatest credit on its managers. It is too soon yet to attempt any description in detail, but we have seen enough to justify us in promising our readers a most interesting and instructive exhibition.

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The Newcastle Engineering and Mining Exhibition, to be opened by the Duke of Cambridge on May 11th, also promises well. It is to be held in the very centre of the engineering and mining industries, and should afford ample field for the necessary exhibits. The Corporation have placed an extensive area at the disposal of the executive, and the covered portion of the exhibition will extend over 241,000 feet, of which some 59,000 feet will be devoted to mining operations. The erection of the building will cost £21,000.

The exhibits are divided into fourteen sections, some of which are of great local importance, such as "Coal Mining and Products," and "Chemical Industries." The mining division is expected to contain a large variety of interesting exhibits. In this class there is to be a working model of a coal mine, built entirely of coal, and about 150 yards long by 50 yards wide. This will show the exact method of working a coal-mine. There is a class for sundry products, which include rope, silk, canvas, hats, lace, tobacco, etc., etc. The division for "Art Industries" promises to be well supported with loans of pictures.

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This undertaking should be a great success, and tend still further to the development of a locality which has played so important a part in mining and engineering.

The whole building will be lighted by electricity, and it is said that there are in course of construction some remarkable novelties in electrical engineering. The lights of the theatre will be so arranged that they can be reduced from sixteen-candle power to about one-candle power at the will of the stage manager. This is arrived at by arranging resistance coils of iron wire outside the theatre, with a switch board placed on the stage. From the *Electrical Review* we learn that there will be an electrical smithy, where experiments will be made in the welding of metals by the assistance of a strong current. There will also be shown an electrical rivetting machine of an entirely novel character, and an electrical railway will be another attraction.

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War and Invention.—Under this heading our contemporary, *Scientific American*, again reminds its readers that war in European countries offers a large field for labour-saving appliances. As a very large percentage of the effective manhood of each nation is sent to the field or into garrison, there is not only a call for purely warlike inventions, but for many connected with the arts and manufactures. It is also pointed out, that a machine that can be managed by a woman will take precedence in war time of one requiring the care of a man. Attention is called to the fact that one of the important requisites of a land campaign, is an efficient transport service for food, ammunition, clothing, arms, hospital stores, general supplies, and for the sick and wounded. In fact, anything which simplifies or lessens the cost of transport becomes a necessity to a great army. A long list is then given of the many subjects for invention which would receive a special impetus from a great war, adding that the inventor will readily add the thousand-and-one developments and subdivisions of the list. The moral is, that there is enough to show that the inventive genius of the American people can be actively and profitably employed, in case the great European powers should unhappily prefer war to peace.

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Some New Experiments with Fibres.—Mr. C. V. Boys, M.A., has recently read a very interesting paper before the Physical Society "On the Production, Preparation, and Properties of the Finest Fibres," in the course of which he described some curious experiments, and revealed some unexpected qualities possessed by the substances experimented on. For certain purposes in connection with delicate scientific instruments fibres of great tenacity, and unaffected by "torsional fatigue" are required. Mr Boys appears to have succeeded in producing fibres of quartz less than $\frac{1}{100,000}$ inch in diameter, possessing a tenacity of about fifty tons on the square inch, and quite free from "torsional fatigue." His method of production as applied to glass is as follows:—A rod of the substance is held at one end, while the other end is cemented to the tail of a straw arrow arranged to be projected by a cross-bow. The middle part of the rod is heated to the required temperature; the string of the cross-bow is then suddenly released, projecting the arrow with great velocity, and drawing out a long fine fibre. By this means fibres of glass less than $\frac{1}{10,000}$ of an inch can be made. Mr. Boys exhibited an annealed glass spiral capable of weighing a millionth of a grain fairly accurately. He has experimented on many minerals, and with quartz has obtained the result alluded to above. Garnet, when treated at low temperatures, yields fibres exhibiting the most beautiful colours. The following experiments will doubtless be repeated by many of our readers who possess a suitable machine. Mr. Boys found that if sealing-wax, or any similar sticky substance, is melted in a cup and put upon the conductor of an electrical machine, it will begin to throw out threads in an extraordinary way; the fibres are large when the resinous matter is very hot, each fibre shooting out as a cylinder with remarkable speed, then breaking into beads. These minute beads can be made to patter against a drum head, and make a noise upon it like falling rain; the cup containing the wax should be inclined from the operator, and from the electrical machine before the latter is worked, or both will be covered with the most invisible sticky web imaginable; a cup of burnt indiarubber tubing so heated sends out almost invisible filaments. Canada balsam is the perfection of a material for producing such sticky threads. When a candle is held near a cup throwing out such electrified filaments they shoot into the flame, and sometimes cover the candle; sometimes they will stop as they approach the flame, then turn back, and go into the cup from which they started, in consequence of discharging the electricity into the flame. In a few minutes miles of these sticky threads can be made, and as they break into beads the method affords a ready means of powdering such of these substances as are not easily pulverised in any ordinary way.

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THE CITY AND SOUTHWARK SUBWAY.—There could hardly be a better illustration of the progress of engineering science during the last fifty years or so than the fact that within a few months a tunnel beneath the Thames, close to London Bridge, has been begun and finished with comparatively very few people being a bit the wiser. When Brunel at last joined the two banks of the river by boring under its bed, it was considered that another wonder had been added to the world's stock, but now such a feat is a matter of course. The tunnel referred to has been made by the City and Southwark Subway Company. It is designed to afford an easy and rapid means of communication between the City and the Surrey side of the water. There is to be a terminus at the Monument, and another at Stockwell. The tunnel, or rather tunnels, for there is to be a separate one for up and down lines, are not built for either pedestrian or railway traffic as now generally understood, but will be worked by a wire-rope system, much as the old Blackwall Railway was in days that are fast getting long since past.

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The great feature in the scheme, and the one on which its promise of commercial success is based, is that no compensation is to be paid for the use of land, damages to business, etc., excepting in one trifling instance. The tunnels are to follow the lines of the public street, and where the street is too narrow to allow them to be placed side by side, they will be arranged one over the other. These tunnels are carried at a sufficient depth to go under everything—foundations of buildings, gas and water pipes, and all other vested interests. Each tunnel is 10 feet in diameter, and is composed of iron rings bolted together. On account of the great depth at which the lines run, the labour of getting up and down by ordinary stairs would be excessive, so communication with the surface will be made by hydraulic lifts. The practicability of this system has been shown by the experience gained with the Mersey Tunnel lift, where 100 passengers are carried at once to heights of 76 feet and 87 feet. On the whole, the new scheme seems to promise well, and if successful will no doubt lead to other lines on the same plan being started. It is certain that London is sadly in want of more facilities for locomotion, and has used up all its surface area.

## GENERAL NOTES.

ASBESTOS.—It is stated that an important and extensive discovery of asbestos has been made in the Umsinga division, South Africa.

THE BIRMINGHAM CABLE TRAMWAY, the construction of which has been in contemplation for some months, has been begun. The whole line will, it is hoped, be ready for use in four months.

CARBONS.—At a trial in Cleveland, U.S., for infringement of patent, a witness testified that of 150,000 carbons burned daily in the United States, 100,000 are manufactured in Cleveland, where there are 20 furnaces.

GAS-LIT OMNIBUSES.—The three-horse omnibuses of the Metropolitan Railway travelling between Portland Road Station and Charing Cross are now lighted with gas. They each carry a store to last three or four evenings.

CHEMISTRY IN AGRICULTURE.—According to M. Adouard it is wrong to mix nitrates with superphosphates in order to spread them on the soil, as these salts react on one another and some of the nitrogen is lost.—*La Nature.*

QUICKSILVER IN RUSSIA.—Quicksilver is now being worked near Nikitofka station on the Koursk-Kharkoff-Azoff Railway. A pit 280 feet deep is being sunk provided with the necessary machinery. The ores are expected to yield 1 per cent. of metal.

AN EXHIBITION FOR BRUSSELS.—An application has been made by the Belgian Government for a credit of £72,000 to assist the establishment of a museum of industrial and monumental art, and to found an industrial exhibition at Brussels in 1888.

POLLUTION OF THE THAMES.—The Thames Conservators have framed a bye-law to prevent the pollution of the upper river by house boats and steam launches, and these vessels will be required to make the necessary alterations and arrangements to enable them to comply with the bye-law.

CORK BRICKS.—For some time past experiments have been made in Germany with a composition of cork, sand, and lime moulded into bricks for the construction of light partition walls. This, it is said, excludes sound better than brickwork, and is also light and a good non-conductor of heat.

RESISTANT FILTER-PAPER.—A French chemist finds that filter-paper, if dipped for a moment in nitric acid of the density of 1·42, and immediately washed in plenty of water, becomes much stronger than before, and may be used for filtering under pressure without the use of a protecting cone for the tip.

IRON FROM CHINA STONE.—*The Engineer* states that at Par, Cornwall, a process, described as the "extraction of iron from China stone by means of electricity," has been for some time under experiment by the St. Austel Mining Company, and plant is now being laid down for the permanent application of the process upon a commercial scale.

A METHOD OF CRACKING GLASS is given by E. Beckmann. A scratch is made with a file; at both sides of this, pads of wetted filter paper are wrapped round the object, leaving a space of a few millimetres between them. The flame of a Bunsen or gas blowpipe is applied to this space, when the crack will be carried round from the scratch mid-way between the two pads.

THE ITALIAN NAVY.—The Italian Government are having built and engined, in various parts of Italy, a number of first-class torpedo boats similar to those purchased at Elbing in Germany. The engineering works at Genoa are consequently very busy, as they have in hand, besides, the three ironclads, *Sicilia*, *Re Umberto*, and *Sardinia*, all of which are to have engines of 20,000 horse-power.

RAILWAY WHISTLING is not only a source of annoyance to persons dwelling near the lines, but is a positive loss to the Railway Companies. An American engineer estimates that the whistling expenses on a single line of railway, the New York, New Haven, and Hartford, amount to 15,000 dollars a year in the shape of coal burnt to raise the necessary steam.

THE FORMATION OF BRIQUETTES by combining molasses with small coal is rapidly gaining favour in France, Germany, and Belgium. Molasses are very abundant and cheap in these countries, and the addition to the ash of the fuel is not more than 1½ per cent., owing to the comparative absence of any mineral substance in the molasses. The total proportion of ash is about 11½ per cent.

COMPETITION FOR DOMESTIC MOTORS.—The Society of Arts recently offered prizes for motors suitable for electric lighting, but we regret to learn that the committee appointed to deal with the matter have felt themselves obliged to postpone the competition owing to the insufficient number of entries. They, however, hope that at the beginning of next year another opportunity will be given to those willing to compete.

HEATING RAILWAY CARS.—The Secretary of the American Treasury has issued a circular inviting correspondence upon the best methods of building railroad cars and heating the same, and constructing steam vessels so as to prevent loss of life and property by fire. Sketches or drawings are requested from parties offering suggestions. A report will be made to Congress at the commencement of the session in December.

THE LARGEST BRONZE CASTING ever made in America has lately been produced by the Henry Bonnard Bronze Company, of New York. Its destination is Philadelphia, where it is to form part of an equestrian statue of General Meade. In making this casting 7,500 lbs. of metal were used, the proportion being 10 parts tin and 90 parts copper. The completed statue will weigh about 10,000 lbs., and will be 16 feet high.

ACID SOLUTION FOR ZINC BATTERIES.—Dr. Eisenmann, of Berlin, has found that an acid solution capable, when used in a zinc battery, of being regenerated by mere exposure to the air may be obtained by forming a solution of 30 gr. of tungstate of soda and 5 gr. of phosphate of soda, dissolved in 350 gr. of water, with the addition of a small quantity of sulphuric acid. The phosphate is added to increase the solubility of the tungstate.

THE ELECTRIC THEORY OF EARTHQUAKES. — M. Ch. Naudin, in a paper recently read before the French Academy of Sciences, suggests that earthquakes may be due to the resistance, greater or less, which certain parts of the solid crust of the earth offers to the electricity generated in our earth itself. He remarks that the countries ravaged by earthquakes have always been regions void of forests, which may serve for the escape of the electricity.

HOW TO BE HEALTHY.—*Bell's Climatology* says that after all that has been stated of the effects of the atmosphere in high altitudes or at the level of the sea, the influence of forest and ocean, of sea coasts and interior places, humidity and dryness, cold and heat, the winds, electricity, and ozone, and no matter what of other conditions, the paramount considerations for the promotion of health are an abundance of pure air and sunshine and out-door exercise.

RAGS AND PAPER WASTE IN PARIS.—In the report of M. de Luynes, lately submitted to the Committee of Hygiene for the Seine, the following curious statistics are given:—The trade in rags, old paper, etc., etc., gives employment to about 2,000 men and 20,000 women for sorting the materials, and including the collectors and others it is estimated that from 80,000 to 100,000 persons live by this trade.

THE STRENGTH OF SNAILS.—From the *Zoologist* we learn that recent experiments have shown that a snail weighing ¼ of an ounce, when crawling up a window, was able to lift vertically 2¼ ozs., or 9 times its own weight. Another snail, weighing ⅓ of an ounce, was able to draw horizontally on a table 17 ozs., or 50 times its own weight. The same snail, when crawling on the ceiling, was able to move with a weight of 4 ozs. suspended from it.

COMPRESSED WOOD.—A substitute for the boxwood used for loom-shuttles is sought by compressing cheaper woods, especially teak, in a powerful hydraulic press. A force of fourteen tons per square inch is applied. It is thought that a similar process will be used in toughening cheaper woods for use in carriage work, where strength is required. Ash carriage-poles, steamed and then compressed endwise, are far superior to those made from wood not so treated.

ALARMING.—From an American paper we learn that some of the electric tramcars in the United States, which are run from overhead conductors, contain a notice to the effect that "the engineer is to oil the travellers every three hours." Electricians will, of course, understand that the passengers are not referred to; but it is not surprising to hear that the notice gives rise to a good deal of uneasiness in the minds of many people. Probably the Company will find it as well to adopt the term "trailer" instead of "traveller."

CAPTIVE BALLOONS.—To counteract the difficulty of captive balloons blowing down in a strong wind, Mr. E. Douglas Archibald, of Tunbridge Wells, has devised a combination of kite with balloon, for military or scientific observations and signalling. As the "earth-line," which consists of phosphor bronze or electro-plated steel wire, is attached to the side, instead of to the bottom, the kite balloon cannot be turned round or depressed into a horizontal position, as is the case with ordinary captive balloons.

A NEW NON-CONDUCTING COMPOSITION, which is insoluble in hot or cold water, and will stand the atmosphere or steam without deterioration, has been lately produced by a Danish firm. It is made chiefly from sawdust prepared by special process, and is quite harmless to any metal upon which it is used. It is said to be almost everlasting; it is quite porous, so that any leakage passes right through without damaging it, and is therefore quite perceptible. It is said to be already in extensive use in Denmark.

THE JUBILEE NAVAL REVIEW.—The torpedo flotilla at Portsmouth has been for some time preparing for the Jubilee naval review, and the ship basin is crowded with these craft. There are twenty first-class boats of 125 feet long at Portsmouth, and six a trifle smaller. The crews of these will all require training, and it is therefore arranged for them to go to Spithead, four at a time, for a trial of their steaming capacities and quick-firing guns. The review is to be held on the 23rd of July.

A NEARLY PERFECT PENDULUM.—Mr. J. T. Bottomley, of Glasgow, suspends a shot of about one-sixteenth of an inch in diameter, by a single silk fibre (half a cocoon fibre), two feet long, in a glass tube, three-quarters of an inch internal diameter, and he exhausts the tube to about one-tenth of a millionth of an atmosphere. Starting with a vibrational range of one-quarter of an inch on each side of its middle portion, the vibrations can be easily counted after the lapse of fourteen hours.—*Philosophical Magazine.*

INFECTION FROM TELEPHONES.—Dr. Astvatzaturoff, of Tiflis, has drawn attention to the danger of infection arising from the promiscuous use of the mouthpieces of public telephones. To prevent accidents of this kind, he recommends that the mouthpiece should be disinfected every time after, or, still better, before it is used. In other words, some disinfectant fluid should be kept at every telephone station, and the speaker should dip the mouthpiece in the fluid, and then wipe it with a clean towel before using the instrument.

Incendiary Birds.—A correspondent of the *Scientific American* writes : There is a bar-iron mill near here which has been on fire three or four times, and in which the English sparrow may be called the incendiary. These sparrows pick up old pieces of cotton waste, which they build in their nests, among the timbers of the roof of the mill, and in every case of the fires above mentioned these nests were the cause, either from spontaneous combustion, or from sparks from the hot iron striking and lodging in the nest.

Delta Metal.—The "Schweizerische Bauzeitung" states that the large worm-wheels for the "Pilatus" Mountain Railway were cast in delta metal by Messrs. Schweizerische Locomotivfabrik, in Winterthur. For testing the strength and soundness of each casting separately, a test-bar was formed with the pattern, moulded and cast along with it in one piece; the bars were then cut off and tested before spending any work on the main casting, showing the following results with very slight variations :—Tensile strength, 36·5 kg. per sq. mm. = 23 tons per sq. inch. Elongation, 10·6 per cent.

A New Barometer.—*La Science en Famille* gives the following :—"Put a leech in a flask of clear white glass, containing half a litre, and rather wide than narrow. Cover the opening with a piece of coarse cloth, and then there will be a convenient barometer requiring no more attention than the changing of the water once a fortnight. If the leech is coiled up at the bottom of the flask there will be fine weather; but when it comes up to the surface of the water there will be rain. If it moves about the flask with violence there will be a strong wind; but should it make somersaults, or have convulsions, there will be a tempest."

American Locomotives.—According to the American *Car and Locomotive Builder* the number of locomotives built in the United States during 1886 was 1802, of which 1527 were built in contract shops, and 275 in railway shops, at a total cost of probably 15,000,000 dols. Although the production of locomotives in 1886 was large compared with that of the previous year, yet it was not equal to the natural increase of railway rolling stocks, the journal quoted being of opinion that nearly 1,000 locomotives ought to be broken up annually to keep the remaining stock within the age that the engines could be run without ruinous expenditure for repairs.

The Simplon Tunnel.—The cantons of Vaud and Valais have voted a large sum towards the construction of the Simplon Tunnel. It is stated that the Simplon can be tunnelled for £200,000 less than either of the other peaks. The distance from Paris to Milan by way of the St. Gothard is 1,059 kilos., by Mount Blanc 1,102, by the St. Bernard 1,031, and by the Simplon only 940. The distance to be travelled under the Simplon would be 20 kilos., as compared with the 15 kilos. of the St. Gothard Tunnel. The cost of the work, supposing the Simplon route to be adopted, is estimated at £2,120,000 for a single line, or for a double line, £2,520,000; and it is thought that six years would suffice for its completion.

The Lake Superior Copper Mines.—The copper mines of Kewanan, on Lake Superior, are among the deepest in America. There is usually a descent of 50 feet to 55 feet vertical, which is generally equivalent to an increase of temperature of 1 deg. Fah. At the Superior mines the average gradient is about 100 feet to the degree. This is exceptionally low; but the variations among the different mines are very striking, ranging from 76·5 feet to 122 feet per degree. The rock in the mine gives no explanation of this, as the widest divergence is in rock of the same character. It is thought that the proximity to the lake offers the true solution of the puzzle, as the mines nearest the shore have the lowest gradients.

A Sea Telephone.—A report from Fort Myers, in Florida, where Mr. Edison is sojourning, says that he is working on his sea-telephone. According to a daily contemporary, already he can transmit sound between two vessels from three to four miles distant from each other, and is confident that he will be able to increase the distance between his stations as the apparatus becomes more perfect. Up to the present time Mr. Edison has not succeeded in transmitting articulate speech through his sea-telephone, nor is this essential to the success of the system. By means of submarine explosions he is enabled to form a series of short and long sounds in sequence, and by these, as in the Morse system of telegraphy, words and sentences can readily be transmitted.

Reversible Lead Batteries.—In a paper read by Mr. D. Fitzgerald before the Society of Telegraph Engineers, on reversible lead batteries, he admits that, at the outside, only some twenty per cent. of the peroxide is active; the rest, from some cause or other as yet unknown, is useless. Many suggestions have been made as to why the percentage of actual material is so low, and most people seem to agree that a layer of inactive material is, during the discharge, formed over the peroxide, so that conductive contact is incomplete. Whether this be so is not yet known, and it is hoped that so important a question will be closely investigated, for if means could be devised to raise the efficiency of these batteries, their economical advantages would be enormously increased.

Nature-Smelted Iron.—An interesting example of naturally smelted iron is to be found along the North Saskatchewan River in Canada, and about seventy miles above Edmonton, Alberta. There is a lignite formation along this river for several miles, covered by clay shales and soft argillaceous sandstones, which contain nodules of clay ironstone. These have been found to be carbonate of iron and contain 34·98 per cent. of metallic iron. At some time or other this seam of lignite has been burnt, leaving a bed of ashes, burnt clay, and clinkers, now covered by a dense growth of grass and underwood. Out of this mass pieces of metallic iron can be picked sometimes weighing 15 lb. to 20 lb. These pieces of iron are generally very rusty, but when scratched with a file show a bright surface.

A Very Bad Egg.—A curious accident recently occurred in the Peabody Museum at Yale. One of the assistants was examining an ostrich egg received from South Africa, and was trying to pierce a hole in it, when it suddenly exploded with considerable violence. The operator was knocked over, and picked up wounded and in sensible, and the fœtid odour in the room where the accident occurred was overpowering. The egg was without doubt a bad one, but this alone would not account for the explosion, as, if so, all other ostrich eggs which had been kept for a long time would explode in the same way. We may suggest that, not improbably, there had been some interference with the porosity of the shell, so that gas was retained within it under considerable pressure.

The Electric Lighting of the Palais Royal.—We learn that the Compressed Air-Power Company, Paris, will undertake the electric lighting of the Palais-Royal in Paris. The station where the air is compressed is situated at St. Fargeau (about three and a half miles from the Palais-

Royal), and the air motors for working the dynamos will be placed near the Palais-Royal. The application is somewhat novel, and it remains to be proved whether this system of successive transformation of energy for finally producing electric light will not be very costly. It is a question in such a case whether secondary generators might not be employed with greater advantage. However, the company deserve well for trying the experiment in so bold a manner, and the installation can hardly fail to afford valuable information on the subject.

A New Liquid Fuel Furnace, the invention of Lieutenant Pashinin, has been tried and adopted by the Russian Government. A trial was made a short time ago with two steamers fitted with this furnace, the results being successful. It is stated that the trial showed that 1lb. of petroleum refuse evaporated 15·6 lb. of water, or $2\frac{1}{4}$ times more than coal. A sheet of white paper is said to have been held 14 inches above the funnel, and at the end was not in the least discoloured or blackened. At Baku, the price per ton of liquid fuel is often as low as 4d. In other parts of Russia the fuel is not so plentiful and consequently dearer, and the question of economy is studied more than at Baku. The supply of liquid fuel is plentiful in the Black Sea, and it is expected that a large number of the torpedo boats stationed there will be fitted with the new furnace.

Direct Fixation of Gaseous Nitrogen.—At a recent meeting of the Paris Academy of Sciences, a paper was read by M. Berthelot on the direct fixation of the gaseous nitrogen of the atmosphere by vegetable soils with the aid of vegetation. Having already described the results of the experiments made at Meudon on the fixation of atmospheric nitrogen by certain argillaceous and vegetable soils, apart from the action of vegetation, the author now gives the results of the experiments simultaneously carried on with the aid of vegetation, and under the ordinary conditions suitable for the natural development of plants. In this case the amount fixed was only 4·67 and 7·58 grms., as compared with 12·7 and 23·15 in the absence of plants. From these experiments important conclusions are drawn with regard to the rapid exhaustion of the soil under the prevalent systems of forced culture.

Mr. Beecher's Voice.—The *Philadelphia Times* says there is in the house of Mr. Edison, at Llewellyn Park, a remarkable memento of the late Mr. Henry Ward Beecher. The inventor's phonograph for impressing on a soft metal sheet the utterances of the human voice, and then emitting them again by the turning of a crank, has never been put to any very valuable use. He, however, used it to make a collection of famous voices, and since he himself became famous his visitors have included many celebrities. Instead of asking them for their autographs or photographs, he has in two or three hundred instances requested them to speak a few sentences in a phonograph. He has kept the plates in a cabinet, and occasionally he runs some of them through the machine, which sends out the words as uttered. Edison is probably the only man who can revive the silenced voice of the great preacher.

Hardening and Tempering Steel.—An American paper publishes a report of tests made of a new process for hardening and tempering steel. A drill made of the new steel penetrated in forty minutes a steel safe plate warranted to resist any burglar drill for twelve hours. A penknife tempered by the process cut the stem of a steel key readily, and with the same blade the inventor shaved the hairs on his arm. A number of other interesting and successful tests were made. The inventor is a young blacksmith, who has been experimenting with the process for years, and who claims that this tempering is done without expense or skilled labour. He has also a new process for converting iron into steel at small expense. He claims to be able to make steel plates so elastic and hard as to turn a ball fired from the heaviest gun ever constructed. It is needless to say that the invention is a secret, and a company has been incorporated to push it.

The Wave-Length of a Ray of Light.—At a recent meeting of the Berlin Physical Society, Dr. Lummer described the experiments of M. Macé de Lepinay, who by a new method had determined the wave-length of the ray of light $D_2$, ascertaining, as he had done, by weighing, the volume of a quartz cube, the size of which was detiermined in units of the wave-lengths, and from the volume of the cube finding the length of the light-wave. He showed a series of inaccuracies in the measurements of M. de Lepinay, and, in view of the fact that the wave-lengths of the rays of light are now measured with a precision of 1-60,000th, whereas the determination of the centimetre was affected with an uncertainty of 1-4,000th, he purposed inversely ascertaining the length of the centimetre from the wave-length. The mode of procedure should be the same as that made use of by M. de Lepinay, yet several improvements in the measuring and weighing were stated, such as the speaker hoped to be able to effect later on.—*The Engineer.*

Oxy-Hydrogen Lamps.—At a meeting of the Berlin Physical Society, whilst speaking on the disadvantages of the oxy-hydrogen lamps, Dr. Koenig explained a new lamp constructed by Herr Linnemann, in which the unsteadiness in the light was avoided. This unsteadiness arises from the fact that in the common lamp the flame burns sometimes in the burning tube and sometimes outside it. In the new lamp the coal gas or the hydrogen issues from a ring-shaped opening in the burner, while the oxygen in the centre is admitted through a capillary tube and does not come into contact with the burning gas till outside the burner. In the middle of the blue flame is seen a bright point which gives the heat maximum. Instead of the lime cylinder, Herr Linnemann uses in his lamp zircon plates, which, at the place of the bright point, give a highly intense constant light. Dr. Koenig made use of this light in order, with the aid of the optical bench of Prof. Paalzow, to demonstrate by projection, a long series of phenomena in connection with the doctrine of the polarisation of light.

Conversion of Heat into Electrical Energy Direct.—Herren Kinghausen and Neoust have recently described in *Wiedemann's Annalen* a fact of very considerable interest. It amounts to no less than a new method of obtaining an electric current by the direct conversion of heat. In some respects this new discovery resembles the effect which was first observed by Hall a few years since, but in the present case a thermal current is substituted for a current of electricity. That is to say, if a thin slip of metal, placed in a magnetic field, have its two ends maintained at different temperatures, then a difference of potential is set up between the two opposite sides of the metal slip. The experimenters state that they have satisfied themselves that the current so produced is not due to any thermo-electric action between the contacts. The fact that the direction of the current is reversed when the direction of the magnetic field is reversed is in itself sufficient to remove this objection. The effect is naturally very minute.

Secondary Batteries.—In a discussion at the Society of Telegraph Engineers and Electricians on the merits of Mr. Fitzgerald's new battery, Professor Ayrton protested against the rating of secondary batteries or "accumulators" in terms of *horse-power-hours*. He considered this very misleading, for, as a matter of fact, a so-called horse-power cell does not give out energy continuously at the rate of a horse-power, or anything like it. To illustrate his meaning, he said that if a man goes to a shop and buys a watch, his expenditure for the moment when his money passes over the counter may be at the rate of £100,000 a year, but it by no means follows that his spending capacity is £100,000 a year because it attains that rate for an instant. Similarly, it does not follow that a horse-power-hour cell will give out the energy of a horse-power for an hour, merely because it attains that rate for a short time. Professor Ayrton therefore urged that a statement should be made of the number of Watts that can be obtained from a cell for a given expenditure of money, say £1.

THE BARK OF THE MULBERRY TREE AS A TEXTILE.—A few weeks ago a company was started in Italy for producing silk, so-called, direct from the bark of the mulberry tree. The promoters of this company, after patenting their invention, went to France, and, having explained the matter to some of the French papers, articles were written on the subject, which excited considerable interest amongst those engaged in the silk industry. It was feared that, by means of this discovery, and the patent taken out on the strength of it, a new monopoly would be established, but on examining the question more closely it is found that the idea was not altogether new. M. Ponsard has written to an agricultural paper *(Le Journal d'Agriculture Pratique)* stating that in 1882 he successfully tried the process, and, further, that the method of working is fully described in a book published in 1804, and written by M. Olivier de Serres. A reference to this book, the title of which is "Theatre d'Agriculture et Menage des Champs," shows that on pp. 147 to 151 there is, among other descriptions of useful and interesting applications of the mulberry tree, an account of the way in which silk may be obtained from the bark. The silk thus obtained is finer than cotton wool and flax, but is not equal to ordinary silk.

WHY PAPER TURNS YELLOW.—All paper will turn yellow finally if time enough be given. Against this change we are powerless. When, however, a paper will not retain its original white colour for a few weeks, or even days, we have reason to complain; and we may assume in such a case that a wood-pulp has been used; not a wood-pulp prepared chemically by means of acids or caustics, but a wood-pulp obtained simply by mechanical operations, by grinding, etc. According to recent experiments of Julius Wiesner, of Vienna, the cause of this change is not so much light, as oxygen, to which almost every fault is now charged. Chips of paper placed in the vacuum over the mercury, in a barometer tube, kept perfectly white, even when water was present. But exposed to the direct sunlight in the air, the paper turned rapidly; and a strong sunlight was found very much more dangerous than ordinary diffuse light; moisture is also pernicious. A further examination with coloured rays proved that the blue actinic rays, particularly active in photography, are mainly responsible for this change. Gaslight is poor in these rays; and, indeed, a sheet of a newspaper illuminated by a gas flame which was kept burning day and night for a whole month, had hardly any yellow tint at all; and when this test had been continued for four months, the paper still looked whiter than another sheet of the same paper exposed to the full sunlight for two hours. Since the electric arc has many actinic rays it follows that the arc-lamp is not the best illuminant for a library. The readers of the British Museum would be pleased if the authorities were guided by these facts, for few would be sorry to see gas substituted for the present trying arc-lights, with their strong contrasts of light and shade. But if gaslight does not turn paper yellow, it has that effect on other things. Wiesner's experiments help to clear up the difference existing in this respect between chemically and mechanically prepared wood-pulp. The chemical treatment destroys certain bodies, which the mechanical treatment leaves intact. Amongst these bodies are vanillin, coniferin, and various gums. Coniferin is entirely decomposed by light, as also is vanillin to a great extent. Jute and straw papers, being not always free from these substances, may also turn yellow.

## DOMESTIC SANITATION.

### No. 1.—WATER SUPPLY.

IT must be conceded that national and local authorities often commit grievous errors in dealing with questions of public health. But the wisest sanitary laws must prove inefficient unless the individual householder has an intelligent insight into the main principles of hygiene, and if he will not act up to such insight. After all our vaunts about "progress," the sanitary code laid down in the Pentateuch should still be far in advance, not, indeed, of our modern knowledge, but of our modern practice.

We purpose, therefore, laying before our readers a brief series of papers on household hygiene. We shall not attempt to give instructions in the analysis of water and air, or to qualify paterfamilias for the duties of a medical officer of health or a sanitary inspector, but we shall point out possible sources of danger and necessary precautions, both of which are too often overlooked, and do what we can towards forming, on this subject, an enlightened public opinion.

The first, and perhaps the most important, point to be considered is the water supply, since water may be, and too often is, the channel through which disease and death are introduced into a family.

It may, perhaps, be thought that since the increasing density of population and the accompanying pollution of the soil and the streams have in most parts done away with private pumps and wells, the individual has here little power, and must simply use whatever fluid is supplied to him by a company, or, in the best case, by the municipal authority. But this is not so; he can often in choosing his residence be guided by the character of the water, or else he can join the agitations for improvement in the quality, such agitations, as public opinion is gradually enlightened, will become irresistible.

The first question concerning water is its quality. Is it hard or soft? It is not to the credit of medical science that in connection with this question there is a striking diversity of opinion. Some authorities maintain that hard waters are preferable for dietetic purposes as supplying the mineral salts which are required in the animal system, and especially in the formation of the bones. They contend that the inhabitants of calcareous districts, where the waters are necessarily hard, are bigger, stronger, freer from disease, and live longer than the dwellers on such formations as the granite or the mill-stone grit, where the waters are soft.

The champions of soft water, on the other hand, argue that the finest specimens of modern Englishmen are to be found in the "back-bone" of England and the adjoining parts of Yorkshire and Lancashire, where the grit-stone formation yields copious springs of the softest water, fed by the very abundant rain-fall. They denounce hard water as being one of the secondary causes of diarrhœa, cholera, and calculi.

But the impartial observer will not feel fully satisfied with the evidence on either side. The death-rate in towns, supplied respectively with hard and soft water, does not vary so strikingly and regularly as to lead to any definite conclusion. And so many other factors have to be taken into account that statistical returns can scarcely be expected to decide the question.

Soft waters have, however, in many respects an unquestionable superiority. In washing the human person or linen, etc., they remove dirt with a very trifling expenditure of soap, and leave the surface clean and free from clamminess. Compare this with the process of washing in a hard water; very much more soda is required, of course at considerable expense, and, after all, the work is very ill done. Of this any one may convince himself by the simple process of washing his hands in a very hard water, such, for instance, as that of Castleton, in Derbyshire, or Kirby Shore, in Westmoreland. He will find his hands, however carefully wiped, retaining a gluey sticky feeling. The soap used has been decomposed by the salts of lime (or magnesia) present in the water, and an insoluble lime-soap has been formed, which adheres to the skin, or to linen, etc., and imprisons the dirt instead of removing it. Hence washing or bathing in such waters is by no means a sanitary process; the pores instead of being opened are clogged up by the lime-soap formed. A recent writer has even gone so far as to ascribe many forms of skin disease to the use of hard waters.

It is further found that hard water is unsuitable for boiling vegetables; they will not be nearly as tender as if they had been boiled in soft water.

The industrial applications of water do not at present come under our consideration. Suffice it to say, that there is scarcely any manufacturing process into which water enters at all, in which softness, in a word, the absence of dissolved mineral matter, is not a primary requisite.

We must, however, refer to the behaviour of hard water in steam boilers, because it is closely connected with its domestic uses. It is now very widely known that users of steam, who feed their boilers with hard water are much incommoded by the formation of a deposit, technically known as scale or crock, which attaches itself to the boiler-plates, and something reaches an inch or more in thickness. This means a double loss; crock is a much worse conductor of heat than is iron, and consequently longer firing is required to get up steam than would be needed with a clean boiler. Further, as the heat of the boiler-plates is not conducted away by immediate contact with the water they are raised to a higher temperature and are sooner worn out. All this we find taking place in tea-kettles, kitchen boilers, and coppers, where there is a hard-water supply.

Fortunately, in those cases, and they are the majority, where the hardness of water is in great part due to carbonate of lime, held in solution by free carbonic acid, it may be softened by the Clarke process. A quantity of freshly-slaked lime stirred up with water into a cream is added. This immediately seizes hold of the free carbonic acid, and the carbonate of lime thus formed, together with that originally present, subside together, leaving the water beautifully soft, and, to a very great extent, freed from organic matter which may be present.

This process—"Clarkising," as it is called—is perfectly practicable on the large scale, and is carried out successfully at Canterbury and at Aylesbury. The water supply of the latter town is derived from wells in the chalk-beds of the Chiltern Hills, and is to begin with very hard. By the Clarke process it is made one of the finest waters in the world, and fit for any use, domestic or industrial. As collected in the store-reservoirs, it displays that beautiful light blueish tint which is characteristic of water very free from organic impurities, when seen in large masses. The colourless appearance of common water is due to the blue being masked by the yellow tint, due to organic matter in solution.

The experience of such places as Canterbury and Aylesbury proves that the Clarke process might be applied with great benefit to hard water. Unfortunately, the majority of water companies wish to do as little as possible in return for the payments which they receive.

We now come to a point in water-supply about which there is very little difference of opinion—the presence of organic matter. All authorities are substantially agreed that organic matter in water is not desirable, though they may differ concerning the degree of danger which it presents.

We must here note that even if a water-supply could be found absolutely free from organic matter, and could be brought in that state almost up to the town which it was to serve, it would become polluted, unless it was made to flow through covered channels, and was delivered on the *constant* system, so as to dispense with that abomination, the cistern. All water open to the air becomes contaminated with dust, and to unprofessional minds an account of the composition of town dust would be anything but appetising. It is nothing uncommon to find in water-cisterns, though the water may be fairly good as it enters, a colony of the wriggling larvæ of gnats and midges, some of which are known as bloodworms. All these creatures have the power of setting up putrefaction of a very offensive type, if anything is present upon which they can subsist.

It must further be remembered that water in cisterns is liable to freeze in winter and to become unpleasantly warm in summer. Happy, therefore, in this respect are towns such as Leeds, Halifax, and Manchester, where the inhabitants draw their water for culinary and dietetic purposes, direct from the pipes, without the intervention of a cistern.

Organic matter is present in water in two distinct states, both objectionable—as lifeless animal and vegetable substances dissolved or suspended in the water and passing more or less rapidly into putrefaction, and as living beings for the most part visible only with the aid of a powerful microscope. These beings, often spoken of as "germs," are for the most part plants—fungi of a very low order, technically known as *bacteria* and *bacilli*. They differ very greatly in their properties. All have the power, more or less, of setting up transformations in animal and vegetable matter, dead, or even, under certain conditions, while still living. But while these changes are in some cases harmless, they are in others, deadly. Experience has taught mankind long ago that "a little leaven leaveneth the whole lump," and on this principle an infinitesimal quantity of these germs, introduced into the body of a large animal, may set up fermentations known as cholera, typhoid fever, dysentery, splenic fever, yellow fever, and the like. Thus an impure water-supply is a common, perhaps the most common, channel by which these forms of pestilence are spread from one sufferer to another. Hence the immense importance of a pure water-supply to every community. The teachings of modern research, chemical and microscopical, bid us exclude from water intended for the use of man or even of cattle all putrescent or putrescible matter. It is very true that normal sewage may often contain no germs of any specific disease. But if we take our drinking water from a river polluted with sewage or with the drainage of highly-cultivated and richly-manured lands, we are never safe.

Hence the water-supply of cities becomes a difficult question. To obtain daily 180 million gallons of a water above suspicion—the quantity requisite for London—is a grave problem. Some sanitary authorities have, therefore, advocated the adoption of a two-fold water supply, the one as nearly pure as possible, to serve for drinking, cooking, baking, washing, etc.; and the other, of a second quality, for working water-closets, watering the streets, extinguishing fires, and the like. For such purposes the water of the Thames would be amply good enough.

The objections to this double system turn chiefly on the expense incurred both to the owners or occupiers of houses and to the municipal authority. A more serious objection to a dual supply would be the risk of confusion. A careless cook might happen to make our coffee or our soup with unfiltered Thames "entire," instead of with the pure water conveyed, as some propose, from the head waters of the Severn.

Wherever the slightest doubt exists, water for drinking and cooking should before use be passed through a spongy iron filter, or one of unglazed porcelain on the Chamberland principle.

(*To be continued.*)

## FERMENTATION.

If we wished to illustrate the great distance which has existed between the practical knowledge of the manufactures and the theoretical researches of the scientific man, we could not find a more striking example than the process of fermentation—a process to which we owe our daily food and our common drink, a process made use of from the earliest times, and yet one the true nature of which it has remained for the thinkers of the latter half of the present century to reveal to us.

We know that the Egyptians made use of a strong drink prepared from corn, similar in some respects to beer, about 2,000 years B.C. We read of the unleavened and leavened bread of the Hebrews in the book of Exodus, and of strong drink being forbidden to the priests in the book of Leviticus. Among classical writers, Herodotus, Æschylus, Xenophon, Pliny, and Tacitus mention fermented drinks in use in all then civilised countries, and we know that the production of fermented drinks has been carried on continuously to the present day. Yet we owe to Pasteur our first accurate information respecting the ferments, their nature, habits, and varieties.

Ferments have been many times classified into vinous, acetous, putrefactive; but these were believed to succeed one another, as simple chemical changes, or to form the links of a circular chain, one passing into another and having to be arrested as alcohol or vinegar might be required.

In a standard work on brewing, published about a century ago, fermentation is defined as a "spontaneous separation and removal from their former order of combination, and a remarkable alteration in the subject by a new arrangement and reunion."* The same dimness of ideas prevails even in the scientific works of a later period, and we read in the "Penny Cyclopædia," † published about 1830, that "Fermentation denotes the spontaneous changes which occur in certain vegetable and animal matters, and by which there are produced new fluid and gaseous compounds." With the use of the microscope came greater light, and in Ure's Dictionary, published in 1853, we read, "Yeast when viewed in a good achromatic microscope consists of translucent, spherical, and spheroidal particles, each about $\frac{1}{6000}$ inch in diameter. The researches of Schulze, Cagniard de la Tours, and Schwann appear to show that the vinous fermentation and the putrefaction of animal matters—processes which have hitherto been considered as belonging entirely to the domain of chemical affinity, are essentially the result of an organic development of living beings. . . . . . As the extract of nux vomica is known to be a poison to infusoria (animalcules), but not to vegetating mould, while arsenic is a poison to both, by these tests it was proved that the living particles instrumental to fermentation belonged to the order of plants of the confervoid family."

Notwithstanding this great step in the direction of truth, some of our great thinkers still fought for the chemical theory, and to the close of his life one of the greatest chemists of his age, Liebig, maintained the theory of chemical development, even when Pasteur had already advanced far in those experiments, the result of which has placed him amongst the greatest of modern scientists. Although, seen by the light of more recent researches, Liebig's *theory* is known to be incorrect, the *practices* recommended by him are such as to be most beneficial to the brewer and baker. He found at what temperature alcoholic fermentation must take place to render the products stable, not liable to further change. He instructed the brewer to aërate the worts as much as possible, as oxygen was necessary for healthy fermentation.*

But Liebig further says: "When we examine strictly the arguments by which this vital theory of fermentation is supported and defended, we feel ourselves carried back to the infancy of science. . . . It may be compared with the idea of a child who explains the rapid fall and current of the Rhine through the numerous Rhine mills at Mayence, by supposing that the mill wheels, by their force, urge the water downwards towards Bingen."†

But leaving past errors, Pasteur has proved that fermentation cannot take place in the absence of organisms, minute as they may be, yet not too minute to be examined even with the present power of the microscope. These organisms may be added to the saccharine solution purposely and separately, as in the case of adding yeast to malt wort, or together with the fruit itself, as in the case of grape must, or cider, where the ferment is present on the skin of the fruit, and is used unconsciously, thus giving rise to the theory of spontaneous fermentation. The changes which take place in beer, either before or after its completion, which give sour or other unpleasant flavours, are due to separate organisms, introduced either with the yeast itself or clinging to the utensils employed, or they may be floating in the dust of the atmosphere. These disease germs are smaller and more delicate than the yeast germs, and consequently can be disposed of by antiseptics, which only weaken the yeast.

Neither of these ferments can in any case develop into any other.

True alcoholic ferments require oxygen for their vigorous growth, and although yeast may exist without oxygen for a longer time than some other ferments, it becomes weak and impoverished without an abundant supply.

Moreover Pasteur has confirmed Liebig's theory of fermenting at a low temperature, but we must agree rather with Dr. Graham in taking exception to Pasteur's recommendation of German beers for stability. The system on which they are brewed makes them so susceptible to change of temperature as to render their transport without ice impossible.

While acknowledging the great debt due to Pasteur for his researches, we cannot agree with the revolution in English manufacture of beer which he advises. The alteration of method, and change of costly appliances, would be a drawback, and there is no safeguard that the products would be as saleable as what is manufactured under present conditions. The so-called Pasteurization of beer may also practically be considered a failure. Although recommended more than ten years since, it has never gained favour in

* Shannon, on "Brewing, Distilling, Wines, Cider, Spirits, Vinegar," p. 145.

† Vol. x. Article, Fermentation.

* This led to the introduction of refrigerators on Bandelot's system. When the first of these was introduced into an English brewery, a number of large brewers met to consider its merits, and all but one condemned it without hesitation, "as a certain way of producing vinegar." This identical machine is still in full work, although the patent has long since died out, and many imitations have followed it.

† "Letters on Chemistry," p. 258.

England, probably because heating beer to a temperature which would destroy all disease germs, would destroy the pleasant flavour of the beer by flattening. Again, Pasteur has fallen into a serious error of observation when he says : "A brewer never prepares his own yeast ...... the interchange of yeasts amongst brewers is a time-honoured custom which has been observed in all countries at all periods, as far back as we can trace the history of brewing."* While by no means denying that such a custom has been observed, we maintain that it is based on a wrong theory and need not be maintained in practice. Several brewers now, knowing the value of their own particular growth of yeast, cultivate it with great care, and would look with suspicion on any strange growth introduced in their brewery. In one case this continuous propagation has continued for thirty, probably fifty years, and the yeast shows no sign of deterioration.

As one fact well established is worth any number of hypotheses, we are content to leave this unexplained, but we are of opinion, that with the increased use of the microscope and its greater powers, much may be discovered respecting the varieties of alcoholic ferments. The theory has already been started that a perfectly pure yeast (*Saccharomyces cerevisiæ*) would give an insipid beer without character.

We would merely suggest in the foregoing remarks that in spite of the incalculable value of the researches of Monsieur Pasteur, to whom brewers will always owe a debt of gratitude, there still remained, after the publication of his work, a wide gulf between empiricism and pure science. How far recent experiments have gone to bridge this over remains to be considered on another occasion.

*(To be continued.)*

## NOTES ON THE HEATING OF BUILDINGS.

No. 2.—Hot-Water Circulation (*continued.*)

THE boilers already referred to are generally used with circulating pipes, having internal diameters of from two to four inches, and the maximum temperature of the water in them may be assumed not to exceed 180° Fah., or the water in the boiler would be above the boiling-point (212° Fah.).

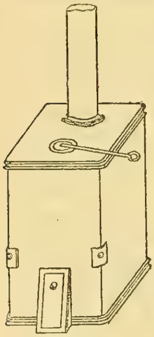

Fig. 18.

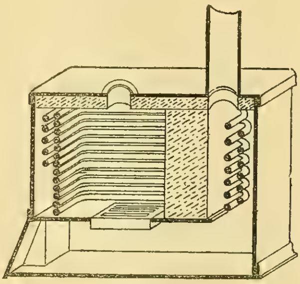

Fig. 19.

We may briefly describe this system as one in which the volume of water in circulation is large, in which the surface of piping which radiates heat to the building is also considerable, and in which the temperature is moderate. We now have to consider a system in which the volume of water and the heating surface of the piping are both small, and in which the temperature is comparatively high. The

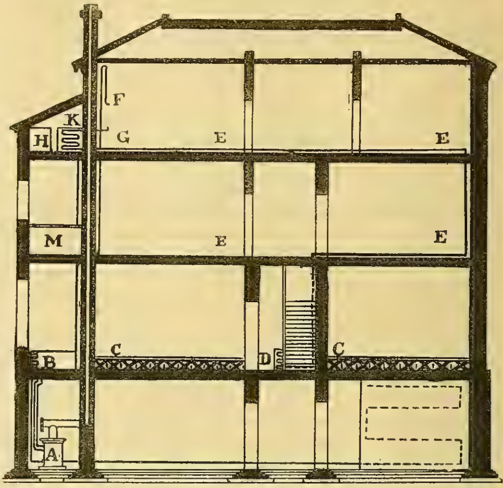


Fig. 20.

system we refer to is generally known as Perkins's, and in it the circulating pipes are less than one inch internal diameter. It has also some other special features, to which attention will be drawn. In the Perkins system there is no

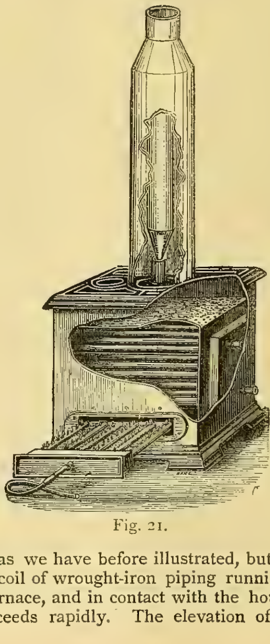

Fig. 21.

boiler such as we have before illustrated, but the water is heated in a coil of wrought-iron piping running round the walls of a furnace, and in contact with the hot fuel, so the heating proceeds rapidly. The elevation of this furnace

* "Studies in Fermentation," p. 186.

is shown in Fig. 18 and the section in Fig. 19. The piping in which the hot water is circulated in the building is a continuation of the coil, and a further peculiarity of this system is that there is no opening or vent in the whole of the piping, so that the water in it is hermetically sealed, and its temperature can be raised above the ordinary boiling-point without it being converted into steam. Provision, however, is made for the accumulation of the contained air, and for expansion of the water, by having one or more tubes of larger diameter placed above the highest level of the circulating pipes. A tube is also provided at the highest point for charging the apparatus with water without filling the expansion tubes. In this system the circulation obeys the

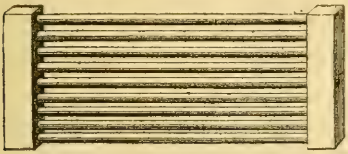

Fig. 22.

Fig 23.

same laws as those we have already considered. The water is heated in the coil placed in the furnace; it then becomes lighter, and rises quickly to the highest point in the circulating pipes. As it travels further, it is cooled by conduction and radiation, and in so doing it becomes heavier, and this causes an unequal pressure in the ascending and descending pipes, and a continuous circulation is established.

The Perkins small tubes occupy little space, and are not unsightly; moreover, it is comparatively easy to carry out with them a complicated system of piping, because the pipes are made of wrought-iron and are of small diameter. For these reasons they are much used for the heating of rooms in dwelling and business houses, especially when several floors have to be provided for. An illustration of this is given in Fig. 20, in which A is the furnace; B, a room heated by a coil of pipe; C, C, rooms heated by pipes placed behind the skirting, and covered with cast iron gratings; D a staircase heated by a coil of pipe; E,E, rooms heated by pipes fixed to the walls or skirting, and covered or not with gratings as desired; F expansion tube; G filling pipe; H cold water cistern; K cistern heated by a coil of pipe; M bath supplied with hot water from K. With large pipes the difficulty and expense

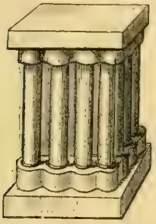

Fig. 24.

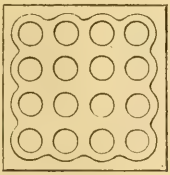

Fig. 25.

of carrying out such a system would be excessive, but for churches, glass-houses, and buildings in which the rooms to be heated are on one or two floors, the larger pipes and larger volume of water are preferable. On the other hand, when the quantity of water in the pipe is small, it can soon be heated, but for the same reason its temperature will soon fall should the fire be neglected.

Apart from these considerations, the chief difference in the two systems is that the one has a large heating surface with water at a comparatively low temperature, and the other a small heating surface with water at a relatively high temperature. Speaking generally, the latter is more efficient than the former, because the greater the difference in temperature between the pipes and the rooms to be heated, the more rapid is the transference of heat. On principle, therefore, the Perkins system has this advantage, in addition to those already referred to; but it is right to point out some practical considerations in addition to those already mentioned. It should be remembered, for instance, that our comfort depends greatly not only on the warmth of the air we live in, but on its feeling sufficiently dry or moist, as the case may be. By this it must not be supposed that the quantity of moisture is increased or diminished, but that the capacity of air to absorb moisture is increased when the temperature is raised. Our judgment is, in fact, independent of the actual quantity of moisture present, and in summer or winter we talk of the air being either dry or cold, not because there is any difference in the quantity of moisture present, but because in summer the capacity of the air to absorb moisture is greater, whereas in winter the atmosphere is nearly saturated. With the Perkins system, it will easily be understood that as the temperature of the pipes is high, so the air which has been in contact with them

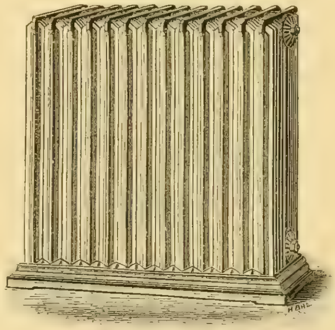

Fig. 26.

becomes thirsty for moisture, and consequently there is a likelihood of moisture being too rapidly absorbed from the skin of persons living in rooms so heated. It is, therefore, essential to accompany such a system of heating with efficient means of ventilation, to insure a good supply of fresh air and sufficient moisture to give a feeling of comfort to those present.

So far we have dealt with boilers heated by fires, but before passing to another branch of our subject we should mention that during the last few years a considerable number of gas-heated boilers have been used for moderate lengths of piping. The best of these with which we are acquainted is that shown in Fig. 21, and made by Messrs. Hartley and Sugden, of Halifax. In this there is a waterway on two sides, and these water-ways are connected by a large number of horizontal copper tubes, so that water can circulate through them freely. The tubes are heated by jets of gas underneath, the products of combustion being carried off by a suitable flue pipe. Inside the lower part of the flue pipe there is an inner tube, tapered and closed at both ends, and as this becomes heated it prevents the condensation of the water vapour which forms a considerable portion of the products of combustion. This promotes the removal of the products, and insures a sufficient indraught of air for the complete combustion of the gas; it also minimises the effect of a down-draught. The following particulars are given by the makers :—

*Table III. giving particulars of gas-heated boilers.*

| No. | Dimensions. | | | Length of 2 in. pipe which each boiler will heat. | Average consumption of gas per hour. |
|---|---|---|---|---|---|
| | Length. | Width. | Depth. | | |
| 1 | 16 ins. | 11 ins. | 17 ins. | 50 feet run. | 25 cubic feet. |
| 2 | 18 „ | 12 „ | 18½ „ | 100 „ | 35 „ |
| 3 | 22½ „ | 15½ „ | 23 „ | 200 „ | 50 „ |
| 4 | 30 „ | 16 „ | 31 „ | 350 „ | 80 „ |
| 5 | 38½ „ | 16 „ | 31 „ | 500 „ | 120 „ |

For very small boilers, gas at 3s. per 1,000 cubic feet will not cost more than the average expense of a coal or coke fire, if account be taken of the waste and the attendant's

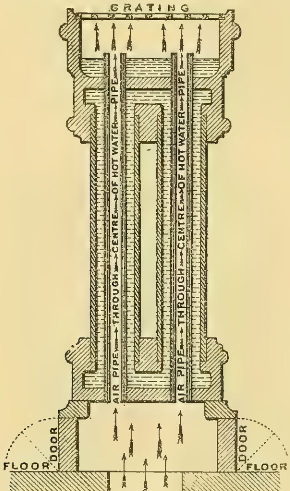

Fig.27.

time. For larger sizes, however, the cost will be in favour of fires; but with gas it is much more easy to regulate the temperature, and no attendance is necessary.

When hot water is used for heating buildings, it is necessary to have in each room one or more coils or groups of piping to give a sufficient surface from which heat can be radiated. Some examples of these are given in the follow-

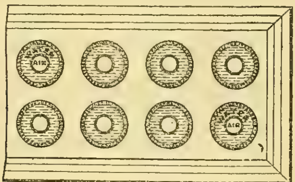
Fig.28.

ing illustrations :—Figs. 22 and 23 show the elevation and section of a horizontal coil, and Figs. 24 and 25 of a vertical coil of simple construction. Fig. 26 is a radiator, made by Mr. J. Keith, which is built up of vertical sections bolted together, and shaped so as to give as large a radiating surface as possible. It is well designed for its purpose. Fig. 27 is a vertical section, and Fig. 28 a sectional plan of a coil made by Mr. J. Weeks, in which an air pipe, open at both ends, is inserted through the middle of each hot-water tube. In this way the heated surface exposed to the air is largely increased.

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## POISONS IN THE HOUSEHOLD.

WE are not for the present about to discuss the mysteries and the iniquities of secret poisoning, or to re-open the *causes célèbres* of the bunglers Palmer, Dove, and Tawell. Our task is less melodramatic and more useful. We wish to call attention to some of the poisons with which modern civilization brings us into contact, and which, through carelessness and ignorance, find their way into our food, our drink, and even into the air we breathe.

Foremost must stand lead, a metal which may be called the meanest and the most treacherous of poisons. If it is introduced gradually into our bodies, Nature "gives no sign." We may go on day by day absorbing more and more of the poison, and when we at last become aware that we have an enemy within us it may be too late. Yet we use this metal or its alloys for lining cisterns, for water-pipes, for taps and funnels, for the so-called tinning of cooking utensils, for the capsules of bottles, and for packing up articles of food.

We must give a momentary glance at some of these items. Water-cisterns are altogether to be condemned from a sanitary point of view, and their lease of life will run out as soon as the constant-supply system is introduced. But, where they are necessary, no lead should be used in their construction. The London water-supply, indeed, has, practically speaking, no appreciable action upon lead, and may stand in vessels or flow through pipes of that metal without becoming poisoned. But the pure waters of the North of England—preferable in every other respect—take up so much lead as to become very dangerous. Our readers may perhaps remember the details of an action brought against the Corporation of a town in Yorkshire by a professional gentleman, whose health had been entirely ruined by lead-poisoning. It is therefore satisfactory to know that Mr. Crookes, Professor Odling, and Dr. Tidy have devised a practical method of lining lead water-pipes with a safe protective material.

Meantime, where the water-supply is "soft," it is a wise precaution to let a few quarts run away at the tap before filling the kettle.

In tinned saucepans, etc., there is no danger so long as the material used is really tin, since tin, though a strong poison if dissolved, is not acted upon by ordinary articles of food. Unfortunately, pure tin is now discarded in favour of an alloy of tin and lead, which readily yields to the acid juices of fruits and vegetables. French cooks are particularly desirous of seeing the insides of their utensils well coated with this objectionable alloy, *la claire*, as they call it; hence we need not wonder that chronic lead-poisoning is more prevalent in France than it is even with us. Fortunately the quality of the "tinning" of a saucepan may be detected by means of a simple test. If the inside is rubbed with a piece of white paper, this should not be soiled; if it is blackened, lead is surely present.

The thin, very thin film of tin lining and coating the cans and boxes in which Australian meats, sardines, etc., are sold sins in the same manner, as does also the tin-foil used by confectioners. Of course the quantity of lead than can be introduced at once into a man's body, through these and similar channels, is infinitesimal, but the process goes on silently and slowly, and at last the critical point is reached.

Leaving lead, the fitting type of an age of fraud, we turn to one of its companions—zinc. At one time this metal was recommended to dairymen for bowls and pans, as causing the cream to rise more readily to the surface. This was really the fact, but the recommenders overlooked a slight drawback. The fatty matter of the milk and the lactid acid, as fast as formed, dissolve zinc and become poisonous. It is of course known that a moderate dose of the sulphate of zinc causes severe vomiting, and is thus at once expelled from the system; but in other forms it occasions severe illness. We remember a case which occurred lately in America. Three persons were attacked with every symptom indicating a corrosive poison, and narrowly escaped with their lives. They had been eating "canned" tomatoes. On inquiry it appeared that, in soldering up the tins, the use of resin had been discarded in favour of chloride of zinc, which is cheaper, easier to use, and very poisonous. Perhaps the most serious feature in this case is that, under very conceivable circumstances, some innocent person might have been accused of intentional poisoning.

Of all poisons the most generally-known and dreaded is arsenic, in its various states and combinations. It is not generally introduced into articles of food, though we have heard of a woman who had access to some white arsenic (obtained for the benefit of the rats), and who mistook it for ground rice (!) and made it into a pudding. No less lamentable was the fate of a woman at Huddersfield, who, being troubled with heartburn, bought and took a dose of prepared chalk. By some mistake she had been supplied with so-called French chalk, and in some mysterious manner this French chalk had been mixed with a large proportion of white arsenic.

But the channels through which arsenical compounds usually enter our bodies are very different. Unfortunately not a few of the colours used in the manufacture of paper-hangings and of painters' colours are arsenical. This refers especially to greens, some of the most pleasing of which are compounds of arsenic and copper. On careful analysis, however, arsenic has also been found where its presence seems gratuitous—in greys, drabs, reds, etc. Now, concerning the poisoning experienced by persons living, and especially sleeping, in rooms hung with arsenical papers, there has been much discussion, some authorities exaggerating the mischief and some denying it altogether. One eminent chemist, who has been practically conversant with the manufacture of "emerald green," holds that if the arsenious oxide present in the colour were given off, either as such, or were first converted into arseniuretted hydrogen, the green colour of the paper would disappear, which is not the case. He points out, also, that the men employed in the manufacture of this substance, and who, when packing it for sale, are enveloped in clouds of its dust, have not been known to suffer from arsenical poisoning, because they get used to it, like the Styrian arsenic-eaters. It is a curious fact, however, that it is (or, at any rate, was at the time emerald green was so fashionable a colour) customary to pay the men employed in its manufacture additional wages, and the hands working at it were changed week by week.

On the other hand, there is a large amount of incontrovertible evidence showing the reality of the mischief. Some persons—for all are not susceptible—on having to occupy a bedroom the walls of which are covered with an arsenical paper, are soon attacked with a series of distressing symptoms, and can obtain no relief from medical treatment. But if they try a change of air, or even change one room for another, they forthwith experience complete relief. And if they do not return to the same room, or to one papered with a similar material, this relief proves lasting. If, however, they do so return, the symptoms recur also. Again, it has been found that some men can work at emerald green making almost with impunity, whilst others would never seem to get, as one might say, acclimatized to it. Among the more common affections are chronic sore throat, inflamed eyes, nervous prostration, sickness, cramp in the bowels, etc. In all these cases the wall-paper has been found, on careful analysis, to be rich in arsenic. From some flock-papers 59 per cent. of arsenic has been obtained by Professor Taylor, the late eminent toxicologist. Another important point in the evidence is that if the arsenical paper is carefully removed and if a non-arsenical paper is put in its place, the room may then be occupied with impunity even by a person who formerly suffered severely. This, of course, proves that, save the paper, there was nothing injurious in the room.

But wall-papers are by no means the only articles coloured with arsenical preparations. "Emerald green" is in great request for lamp and candle shades, for the backs of playing-cards, for artificial flowers, and for colouring wax or paraffin candles. All such objects are, of course, more or less dangerous for household use. The coloured candles are perhaps the most objectionable, since, as they burn, the poison is diffused in the air.

We come next to children's toys which are gaily ornamented with a tempting assortment of poisons. White-lead, red-lead, chrome-yellows and oranges, and arsenical greens are used without scruple. This is the more to be condemned since young children invariably suck or lick anything given them to play with. In the cheaper kinds of toys, the colours are not applied as oil-paints and covered with a good coating of varnish, but are simply mixed with size or even with water. Hence if rubbed or wetted the colour "comes off" with the greatest ease.

Much mischief has been wrought, in former times more than at present, by poisonous colours used in the decoration of sweetmeats, jellies, bride-cake, blanc-mange, etc. Here our old friend the arsenical emerald green once more puts in an appearance. Now, for the application of poisons to such purposes there can be no excuse. Cochineal and safflower yield every shade of red; quercitron bark supplies a yellow, indigo, a blue, and a beautiful green may be obtained by bruising raw coffee and steeping it in white of egg. In some countries official lists have been drawn up showing what colours may be lawfully used for ornamenting foods and beverages, and which, on the contrary, are strictly prohibited. We have not arrived at such a needful precaution. But, perhaps, the right to poison each other—in the way of business—is one of those liberties which we Britons cannot think of surrendering.

There is another possible, or at least conceivable form of poisoning which has given rise to sensational statements innumerable. This form has come under notice only since the introduction of the coal-tar colours in dyeing and tissue-printing. No one seeks to deny that some of the primary materials used, such as aniline and nitro-benzol, are decidedly poisonous. Unfortunately, too, the reagent first used for converting a mixture of aniline and toluidine into magenta was arsenic acid. The earlier manufacturers of magenta, too, were not perfectly versed in the art of eliminating the residues of arsenic from their magenta, and this colour consequently came into the hands of the dyer and the calico-printer in a decidedly impure condition. And as magenta, besides being extensively used as such, served as the raw material for manufacturing the aniline blues and violets; hence, not unnaturally, the coal-tar colours were condemned as a whole.

Another circumstance has here intervened. Some forty years ago the arts of the dyer and the tissue-printer were exercised mainly upon materials destined for outside garments. Articles likely to come into immediate contact with the skin were for the most part worn colourless. The only exceptions were flannels dyed with cochineal, which were deemed salutary in rheumatism, and stockings, dyed either black with copperas and logwood in the old-fashioned style, dark blue with indigo, or greys made by "scribbling" the above blacks and blues with undyed wool.

But now materials dyed all the colours of the rainbow are worn in immediate contact with the skin, and complaints of unpleasant consequences not rarely "go the round of the papers." Now, many of these complaints are grossly exaggerated; some carry impossibility on their very face, but there still remains, we fear, a basis of fact. It may be urged with truth that arsenic is no longer employed by the leading colour manufacturers in the preparation of aniline colours, and that neither their workmen nor those in our great dye-works complain of any unpleasant results. But it seems that a colour which has no action on the hands may cause irritation if kept in close contact with the skin of the feet or the chest, being all the time exposed to the action of perspiration. Hence, the wiser course is to use for under-garments undyed materials only.

We have not here entered upon the question of "poisons in the workshop," which, for the present, would take us too far.

## THE ELECTRIC FURNACE AND THE PRODUCTION OF ALUMINIUM AND ITS ALLOYS.

THE metal aluminium has recently attracted considerable attention, and as there appears to be a probability of its use being very greatly extended in the near future, we give a brief account of it, and of two new allied processes for its production, which are believed to contain the promise of great success.

Aluminium probably exists in the earth's crust in greater quantities than any other metal. It has an enormous distribution in the form of its oxide alumina in combination with silica and other bases. The most familiar of its native compounds is felspar, which is one of the constituents of granite and of several other igneous rocks. The clays are more or less pure combinations of alumina and silica, produced by the disintegration of felspar. When pure the

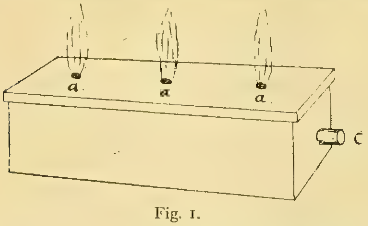



Fig. 1.

clay is quite white, as we see in the porcelain clay of Devonshire and Cornwall, which is derived from colourless felspar.

The uncombined oxide, alumina, is not common. It is found, for instance, as corundum, as the gems amethyst, ruby, and sapphire. Indeed, all the crystalline varieties of alumina are exceedingly hard, the most common being emery, so well known as a polishing substance, and which is mainly corundum coloured with iron oxide.

In spite of the abundant supply of aluminium compounds, the metal itself is so rare and costly, that it may almost be classed as one of the precious metals. But although in the metallic state it has hitherto only been obtained with comparative difficulty, aluminium has for long attracted the attention of metallurgists on account of its possessing qualities which render it remarkably suitable for use in the arts, and for many purposes connected with engineering and warfare. Thus its specific gravity is only 2·67, it being rather lighter than glass, only a quarter as heavy as silver, and one-third the weight of iron. This property was taken advantage of by Napoleon III., who ordered the eagles surmounting the standards of the French army to be made of aluminium instead of silver. Aluminium is not acted on by air even at very high temperatures, and sulphuretted hydrogen, the gas which so readily tarnishes silver, has no effect on it. In fact, it is found to preserve its appearance —that of a bluish-white metal somewhat resembling silver —almost as well as gold does. In the form of certain alloys it has great beauty and strength; thus the gold-like

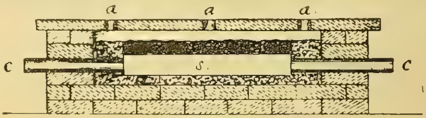


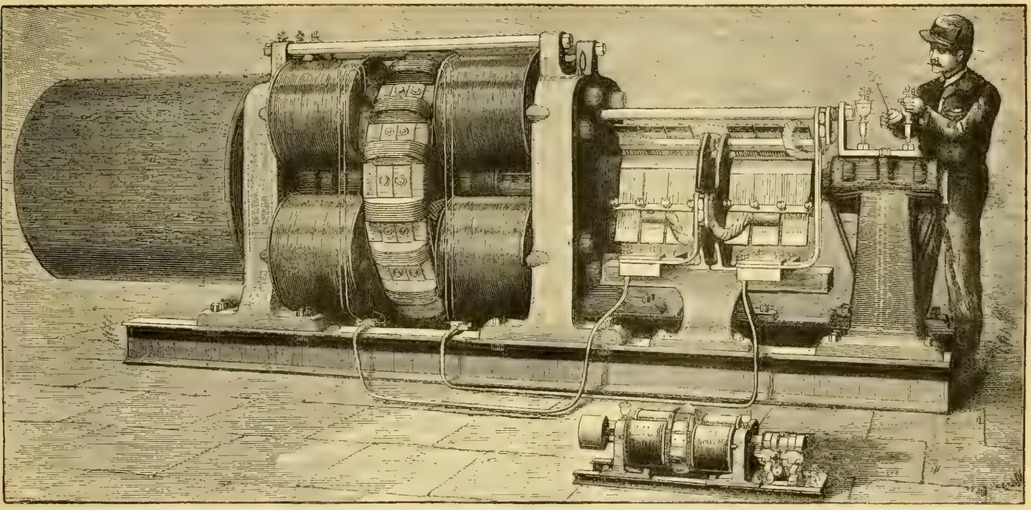

Fig. 2.

alloy of which watch-chains, pencil-cases, and other ornamental articles are constructed, consists of about one part of aluminium and nine parts of copper. It is the enormous strength of some of these alloys or aluminium-bronzes that constitutes their most valuable quality from a practical point of view. This will be understood when we say that the official trials of aluminium-bronze castings have shown a tensile strength which far exceeds that of any forged iron or steel when made into heavy guns; and thus that guns, avoiding all forging, welding, and shrinking on of rings, can be cast in any ordinary foundry and finished in a lathe. Tempering, drilling, and annealing, now required in the construction of heavy ordnance, would also be unnecessary. An extensive use of aluminium must ensue if a cheap process for obtaining it can be developed. Another use of a very promising character has been introduced by Mr. Nordenfeldt, of machine-gun fame, who has found that it is possible to obtain articles of cast-iron equal in strength to wrought-iron, if a little aluminium is mixed with the molten metal. This effect appears to be due to the fact that the small amount of aluminium causes the iron to fuse at a much lower temperature than would otherwise be required. Mr. Nordenfeldt has given the name "mitis metal" to iron heated in this way.

Aluminium has usually been obtained from one of its native compounds, a mineral known as cryolite, by an extensive and rather complicated smelting process. It now appears probable that we shall have it supplied at a comparatively cheap rate by a new process, which has been invented and developed by Messrs. E. H. and A. H. Cowles. This process is extremely interesting, not only on account of its novelty, but because it is applicable to many other than aluminium compounds, and opens out a series of possibilities the importance of which it is difficult to over-estimate.

The process of the Messrs. Cowles consists, briefly, in the use of an electric furnace, in which the temperature attained is much higher than has been possible hitherto, and by means of which highly refractory substances, such as corundum, may be fused and made to undergo decomposition and recombination. The current for heating the furnace is obtained from large and powerful dynamo-electric machines. A small experimental Cowles furnace is shown in Figs. 1 and 2. It consists of an oblong box of fire-brick, the interior space being 5 feet long by 1 foot wide and 1 foot deep. This is closed by a cast-iron slab or cover, having holes, *a*, *a*, for the escape of the gases liberated during the operation. At the ends of the furnace are holes which admit enormous electric light carbons, *c*, *c*, about 30 inches long. The operation of producing aluminium-bronze is as follows :—The furnace is nearly filled with finely pulverised charcoal that has been soaked in a solution of lime and water, and then thoroughly dried. A space, *s*, as shown in Fig. 2, is left in the middle of the furnace. This space is filled with about 18 parts of granulated copper and 14 parts of broken corundum, and some coarsely-broken charcoal. It will be seen by Fig. 2 that the carbon rods or electrodes, *c*, *c*, project into this inner portion of the surface. The whole is then covered with broken charcoal and the lid is put on. The dynamo-machine is connected to the furnace thus prepared, by thick copper cables joined to the carbon rods; and the current is caused to pass through the loosely arranged "charge," fusing the ordinarily almost infusible corundum like wax, and in a very short time bringing the whole "charge" to a fierce heat by the energy of the current. A suitable means of regulation is employed for keeping the current under control, and the carbons are gradually withdrawn, until they are separated by the whole length of the inner space in which the corundum and copper were placed. At the end of about an hour the operation is completed, the current is switched off, and the furnace is allowed to cool. On being opened an oblong metallic and crystalline mass of white metal is found at the bottom of the furnace. This is the copper charged with from 15 to 35 per cent. of aluminium, obtained from the corundum. It is put into a crucible and run into ingots, which are remelted, and "diluted" with copper in the proper proportion to give a standard bronze containing 10 per cent. of aluminium. Every ingot is tested, and none are allowed to pass unless they show a tensile strength of at least 90,000 lbs. per square inch.

Besides the aluminium bronze, other substances, and some of them very curious and interesting, are found in the furnace. A remarkable effect was observed in a bar of the bronze which had been heated for the purpose of forging. It was allowed to become too hot, and when struck, the entire bar assumed a crystalline condition, some of the individual crystals being nearly perfect in form. A striking analogy has been observed between them and certain forms of meteorites. Sometimes small fused rubies and sapphires are discovered amongst the products of the furnace. The sub-oxide of aluminium—never found in nature, and never before known to exist or to be capable of formation—is always present in larger or smaller quantities. Beautiful specimens of white fibrous alumina have also been found. It will thus be evident that very interesting scientific, as well as important economical, results have already been attained by this process, which has been pursued to a successful issue, as far as aluminium bronze is concerned; and which has also been so far successfully applied to the production of the metal aluminium itself in a comparatively pure state that Messrs. Cowles have announced that they expect to be able to put the metal itself on the market in less than a year, at a price considerably lower than has hitherto been demanded for it.



BRUSH DYNAMO FOR AN ELECTRICAL FURNACE.

We are informed that the Cowles Company, of America, have ordered additional Brush dynamos, of the type shown in our illustration above; and that for a foundry which has been established in England, Messrs. Crompton and Co. are constructing a dynamo of still larger dimensions and power. It will be evident that any success this process, or any allied one, may obtain, is due, to a great extent, to the modern dynamo-machine, the improvements effected in which have for the first time rendered it possible to employ the great heating effect of the electric current for metallurgical operations. That this may be done on a large scale will be understood from the fact that the Brush dynamo shown above, which is now being used by the Messrs. Cowles, is capable of continuously yielding heat-energy in the electric furnace equivalent to 11,320,000 foot-pounds of work per minute, or more than 340 horse-power. Dynamos of still greater power may readily be designed and constructed if required. The success obtained by the aid of the thirty horse-power Brush machines, which Messrs. Cowles first tried, was so great that Mr. Brush designed the "Colossus," of our illustration, in order to meet the demands of the larger furnaces which were constructed. We understand that the machine was made complete in all its details, from the specifications of its designer and inventor, and without any preliminary trials; and that when tested, it was found to require no alteration of any kind, and came fully up to the conditions of the contract. The fact that a dynamo may be precisely designed and proportioned for any kind and amount of work that may be demanded, whether for electric lighting, electric smelting, or any other of the applications of electricity, is one of the most interesting and important facts in connection with recent work in this field. Another very valuable factor in the operation of this process is the economy secured by the increased size of the dynamos, it being stated that each new and larger machine has very considerably reduced the price at which the metal or alloys may be produced.

In our illustration a smaller machine is shown. This is the smallest Brush dynamo yet constructed on the same model as the first machine made by Mr. Brush about ten years ago. It was designed to supply a single arc light, a duty which it performed satisfactorily without alteration, exactly as it was constructed from the drawings. It is interesting to note that there is no marked difference in the form and principle of these two machines.

Another electrical method for the production of aluminium has been developed by Dr. Kleiner, of Zurich, who has worked out the well-known laboratory experiment of the electrolytic decomposition of the fused double chloride (cryolite) to what appears to be a practical and successful process. Our readers will no doubt remember that in 1807 Davy succeeded in decomposing potash and soda by passing an electric current through them, and he thus succeeded for the first time in obtaining the metals potassium and sodium. Magnesium, and indeed all metals, can be separated from their compounds by some modification of electrolysis, the familiar operations of electro-plating being instances of the most useful applications of this process. In the case in point, cryolite, when brought to a state of fusion by heat, may be made to give up its aluminium. Dr. Kleiner not only decomposes the cryolite by electricity, after the manner of ordinary electro-deposition, but he heats and fuses the chloride by the same current which he uses to decompose it. Both Messrs. Cowles and Dr. Kleiner use an electric furnace, having carbon rods, from which the current is conducted to the material to be acted upon, and dynamo machines to produce the current; but here the resemblance ceases. Dr. Kleiner's process is distinctly an electrolytic one, the current being made to perform the two functions of decomposing the salt and depositing the metal, as in an electro-plating bath, at the same time that it produces sufficient heat to bring the material into a fluid condition. A comparatively low and quite ordinary temperature is all that is required for the operation.

The Cowles process, on the other hand, is a smelting process, and owes its successful use of electricity to the fact that by this means a temperature so high is attained that the almost infusible corundum is made to part with its oxygen and to give up its aluminium to form alloys with other metals.

How difficult it is to tear aluminium from its compounds will be understood when it is stated that theoretically the utmost amount of the metal that can possibly be obtained by electrical energy equal to 100 horse-power, applied for one hour, would be 1 lb. In practice it is not likely that more than $\frac{3}{4}$ lb. would be yielded per hour by an engine giving 100 effective horse-power. Nevertheless, so valuable is the metal that preparations are being made to carry out this electrolytic operation on a large scale. It will be evident that cheap power is desirable, and those concerned in Dr. Kleiner's interesting process had acquired the rights over half the falls of the Rhine at Schaffhausen, where it was calculated that 15,000 horse-power could be obtained, sufficient to produce 600,000 lbs. of aluminium per annum. This bold scheme has, however, fallen through, owing to the Government having declined to allow the power of the falls to be used in this manner, as it was considered that the picturesqueness of the locality would be seriously affected. This decision, which must have carried comfort to the heart of Mr. Ruskin if he has heard of it, has determined those interested in the process to start a large works in some part of England where cheap coal can be obtained; and to test the process on a comparatively large scale by the employment of steam-engines of about 500 horse-power. We wish them all success in their important experiment.

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## NOTES ON COLOUR.

### III.

THE subject of colour may be treated up to a certain point without the introduction of optical principles; but for the further consideration of several common appearances, the explanation of which is not generally understood, it now becomes necessary to say a few preliminary words on a cognate subject.

Sound is the effect on the ear of vibrations of invisible and almost intangible air. Light is the effect on the eye of vibrations of an invisible, intangible, and all but inconceivable medium called ether, or æther. The conception of ether is nothing new; on the contrary, it is a survival from the times when ethers were as plenty as blackberries. Ethers were provided for planets to swim in; for the transference of "magnetic effluvia"; to assist sensations of touch, etc.; in fact, Nature's abhorrence of a vacuum was sufficient reason for imagining an ether.

We are now taught that there is one ether, a medium prevading all space—at all events as far as light travels, its apparent use being to convey light and magnetism. These two forces are closely connected, and though the form of connection discovered by Maxwell has been questioned, the same ether is probably the vehicle of both. Little resistance as ether gives to the fall of a feather in a vacuum, or to the motion of the planets, or the light and bulky masses of comets, it must be considered to be a solid. It is, however, about $\frac{1}{93,600,000,000,000,000,000,000}$ of the density of water, and yet about 1,000,000,000 times as rigid as steel, or nearly 300,000,000 times as rigid as glass. It is incompressible. The only substance to which it can be compared is a thin jelly. A disturbance is propagated in it as a vibration at the rate of the velocity of light. This has been measured in various ways, and the different results, made with greater care and more exact methods, appear to approach more and more to the value of 30,000,000 metres, or 186,400 miles per second. The velocity of an electro-magnetic disturbance does not differ more from this quantity than the measurements of various observers differ among themselves. The vibrations are not like those of sound, moving to and fro in the direction in which it travels, but at right angles to its path.

Not only do the vibrations travel with this inconceivable rapidity, but they follow each other at the rate of about five hundred million million (500,000,000,000,000) per second. Waves on a lake, travelling at a speed of 200 feet a minute, and following each other at the rate of twenty a minute must evidently be ten feet apart. This distance, measured from crest to crest, or from trough to trough, is called a wave length. The wave length of a vibration of light is about $\frac{1}{42000}$ of an inch.

Sixteen to eighteen simple vibrations of the air in a second produce the lowest audible sound. The middle C of a piano vibrates 264 times a second. The squeak of a bat has about 40,000 vibrations a second, and is the highest audible note for most ears, many people being unaware that this animal makes any sound but a flutter. More rapid vibrations have no effect upon our senses until a scale of 30 to 31 octaves above this has been ascended, when the vibrations are about sixty-two million millions (62,000,000,000,000) a second. Vibrations of the air at this rapidity would have the minute wave length of $\frac{1}{4,600,000,000}$ of an inch, which would be altogether too small to affect any nerve, but the wave length of an ether vibration of this frequency is about $\frac{1}{5300}$ of an inch. It produces the sensation of warmth, and is perceived by the nerves of the skin.

When a rapidity of about 400,000,000,000,000 is reached, the nerves of the eye are stimulated, and the sensation of red is perceived. The wave length is $\frac{1}{33300}$ of an inch. 600,000,000,000,000 vibrations per second produce green, and 830,000,000,000,000 produce violet. The wave length of violet light is $\frac{1}{64000}$ of an inch. The range of audible sounds extends over about eight octaves, but that of colour is almost exactly one octave. Higher vibrations cannot be perceived directly by the eye, but have powerful chemical effect on certain substances, such as those used in photography.

By the aid of the colour diagram in the second chapter of Notes on Colour*, we can trace the effects produced by raising a body to a white heat. At first dark heat rays are emitted, then deep red; and, as was described in the last number of THE SCIENTIFIC NEWS, Capt. Abney has found that there is a great difference among even well-trained eyes as to their perception of the extreme reds. As the body becomes hotter, orange and yellow light is emitted, and by their mixture give a more and more yellow light, and since this colour is the brightest of all, the red becomes almost overpowered; but when the sea-green rays are reached, these with the red make white, and the result is a whitish yellow, and when the blue is emitted it combines with the orange, and finally the violet finds its complement in the green, and a pure white is the result.

There is a difference of opinion as to whether at a higher temperature the blue and violet rays would be emitted in greater proportion than the red, so that the result would be pale blue; or whether they are all given off in the same proportion. It is certain that at the highest temperature of the carbons of an electric arc no pale blue light is perceptible, the violet tinge which is sometimes seen is due in some cases to impurities, and in others to the colour of the carbon vapour of the arc itself, whose light is but a small fraction of that given off by the glowing carbon points which are the real source of light.

The reverse of this series of changes has been exhibited by Prof. Tyndall in one of his most striking experiments. In a darkened room a powerful beam of light is sent through an empty glass tube, and there being nothing to reflect the rays, the space in the glass appears black. A very small quantity of a volatile vapour is passed in, and the particles gradually increasing in size as it condenses, they become capable of reflecting first the violet rays, and then the blue. As the cloud gathers and thickens, the minute drops become capable of reflecting the green rays, and these combined with the violet, form white, making whitish blue; and the orange and red rays, being complementary to the blue and sea-green, at last make pure white.

* See p. 40, ante.

The different tints of blue in the sky are due to small particles of vapour floating in the air. Overhead, where the layer of air is thinner, the blue is deeper; nearer the horizon the thickness in the direction of sight is greater, and the blue is paler. At high altitudes, from mountain-tops, or from a balloon, the colour of the sky is very deep; the more rare the air, the nearer does the colour approach black.

In Captain Abney's lecture already alluded to, the reverse experiment is described, and Prof. Tyndall's experiment, as described, is itself reversible. The cloud which reflects only violet and blue, is naturally transparent to all the other colours, and these together make pale yellow. Thus while the colours of the reflected light pass from dark blue through light blue to white, the transmitted light changes from white to deep red; the sum of the two being at any time equal to white.

The two effects may often be seen together, when thin smoke is seen at one time blue against a dark background, and a moment later orange or brown against a white cloud. Tobacco smoke often appears blue or brown by reflected or transmitted light, as it curls up from the hot ash, but it loses nearly all its colour after partial condensation when puffed from the mouth.

It is difficult to account for the pale green tint not unfrequently seen at sunset. It cannot be produced directly by small particles, either by reflection or transmission, and it is probably the effect of the contrast of reds nearer the horizon. It is often easy to study a small portion of a sunset sky reflected in a pool, with the dark ground as a frame, but even then the horizon tints and the warm hues of the whole scene may affect the judgment.

Minute particles of vapour in the air between a distant mountain and the observer, act precisely as those overhead, and reflect blue light.

It is obvious that the colour is more apparent when the background is dark. For this reason we often see intense blue shadows sweeping over a landscape bathed in sunshine, and the natural redness of the soil or vegetation, or the complementary effect of neighbouring greens will make them purple.

Goethe proposed a theory of colour based upon the production of blues, reds, and yellows by mixtures of black and white, but where it only for the facts that all the tints but the extreme violet and red, which would be very faint, are impure, and that a green is impossible, such a theory is untenable. Its originator probably imagined that greens were easily produced by adding blue to yellow.

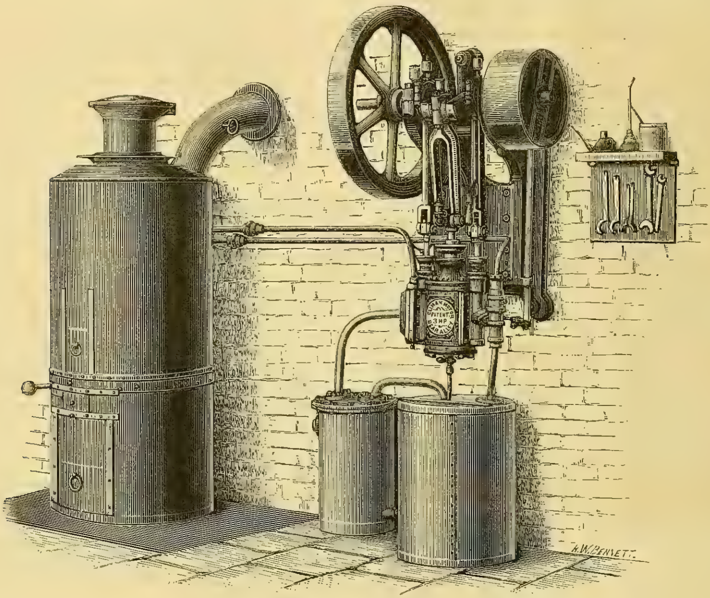
"Those eyes of deep and most expressive blue," and a spot of milk on a tea-tray, owe their tint to no pigment or colouring matter, but to mere turbidity.

## THE CLIMAX MOTOR.

ON p. 66 we illustrate an arrangement of boiler and engine which possesses some features of interest. It has been designed more especially to supply steam power for minor purposes, and has one important advantage in this respect, inasmuch as it is perfectly safe so far as boiler explosions may be concerned. As the boiler is the chief feature, we will describe that first. Our illustration only gives an outside view, but within the light sheet iron casing shown there are a couple of vertical coils of pipe placed one within the other. At the bottom of the space enclosed by these coils are fire-bars, and the fire is made up in what may be described as the cylindrical cage thus formed. In place of the fuel being supplied through a fire door in the usual way, it is dropped in from the top through the lid shown. The curved pipe at the side is, of course, the flue. It will be seen that the burning coals are in contact with the inner coil, which is made of iron pipe. In order to prevent this from rapidly burning away, the cold feed water is introduced at the bottom of this coil. It passes upwards, acquiring heat as it goes, and then down through the outer coil. In the meantime the products of combustion are, by means of suitable sheet-iron divisions, made to pass downwards in contact with the second coil, afterwards ascending to the chimney. The steam formed in the coil is taken directly to the engine without the intervention of a separator, and this, of course, necessitates the whole of the water that is pumped into the coils being evaporated, supposing at least that anything like a good efficiency is to be obtained. How to get this complete evaporation without superheating the steam is a difficulty that has puzzled many inventors, and has never before been satisfactorily overcome. It would seem, however, that the designer of this boiler has practically solved the problem, if we may judge by the records of practical work. The outer coil is made of copper, and the greater heat conductivity of this metal has been taken advantage of to help out of the difficulty. The fact is that the proportions of grate and heating surface are so arranged that the gases are cooled below the temperature that will superheat the steam—at any rate to an undue extent—before they reach the part of the coil where it is possible for complete evaporation to have taken place. In order to make the plan effective, the pump must be designed to throw sufficient water to keep that part of the coil in contact with the fire well supplied with water, but at the same time the feed must not be excessive, otherwise the surplus water would be carried to the engine cylinder. No doubt some water is carried over in this way, but the quantity cannot be excessive, to judge by the indicator diagrams that have been submitted to us.

As we have said, the arrangement possesses the merit of being safe. The boiler should not be expensive to make, and takes up little floor space. For domestic work, and for industries where small power is required, the system appears to be well suited, and certainly gives greater promise of success than anything that has been introduced for some time. Steam can be raised in a quarter of an hour. The whole machinery must, however, be well proportioned, and the boiler especially must not be below its work, for it is not well suited to stand forcing. A very great deal depends, too, on the efficiency of the pump.

The engine itself is of the ordinary type, but contains several ingenious details. In order to get water as pure as possible, a surface condenser, or feed-water heater, is supplied, as shown in the illustration. In the latter case the water is brought to a sufficient temperature to cause it to deposit a large proportion of the mineral salts, held in solution in greater or less quantities in nearly all waters, and which prove such a fruitful source of trouble by forming scale in pipe boilers and heating apparatus generally.



THE CLIMAX MOTOR.

A three-horse power engine on this principle has been erected by Mr. William Bashall, at 17, Bear-alley, Farringdon-street. With this a trial was recently made, and the following are given as the results:—The consumption of London gas coke was 5·6 lbs. per indicated horse-power per hour, and the brake horse-power was 77·2 of the indicated power. These results were obtained with 150 revolutions per minute, and 83 lbs. pressure.

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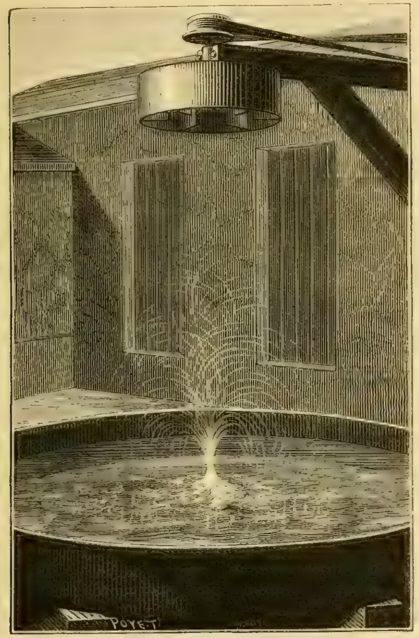
Messrs. Geo. Philip and Son have in the press a second and revised edition of Mr. Horace B. Woodward's work on "The Geology of England and Wales." The same firm promise "Handy-Volume Atlas of the World," consisting of sixty-four plates, containing upwards of one hundred maps and plans, with statistical notes on each map; size when bound 6 in. by 4 in.

## ARTIFICIAL WHIRLWINDS.

AT a recent meeting of the Académie des Sciences, M. Mascart gave an account of some experiments made by M. Weyher to illustrate the action of whirlwinds. The accompanying illustration will assist our readers to understand the effects produced. The drum overhead was about one metre in diameter, and was placed about three metres above the water in the tank below. The drum was closed on the top and open at the bottom, and inside of it there were several blades, as in an ordinary rotary fan. When the drum was rotated the surface of the water was covered with spirals, all converging to a common centre. On the



APPARATUS FOR PRODUCING ARTIFICIAL WHIRLWINDS.

speed of the drum being increased to about thirty to forty metres per second at its circumference, the water was raised in the form of a cone, about twenty centimetres in diameter at the base, and ten to twelve centimetres high. Another cone, inverted, was also formed above the first one, and fine drops of water and spray were carried up higher and thrown out on all sides.

These experiments were made in the open air, and were certainly interesting, as the effects produced so closely resembled those caused by whirlwinds on a larger scale. Any one wishing to try the effects himself can, however, do so with greater ease by using a small apparatus, enclosed in a glass cylinder, so as to avoid cross currents of air and wind, which are troublesome. We are indebted to our contemporary, *La Nature*, for the illustration.

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IN America, in order to save the postman the trouble of knocking at the door when he places a letter in the box, an arrangement is being introduced whereby the raising of the flap of the box closes an electric circuit and rings a bell.

## FORMATION OF DEW.

FROM the days of Aristotle, observant men have supposed that the moon and stars had an important influence on the formation of dew. They saw that it appeared only in calm and clear nights, and concluded that moisture was detached in very small particles from the chill air. The earliest speculators thought that dew fell from the heavens. But in the beginning of the seventeenth century, Nardius, of Florence, made the bold assertion that dew was an exhalation from the earth. After much wrangling, this principle was accepted by scientific men for a century and a half. The experiments of Wilson, of Glasgow, and Sisc, of Canterbury, conflicted with this view, and it was left to Wells to propound the theory which, until a year ago, had been adopted by scientific men.

According to this distinguished observer, dew was condensed out of the air near the surface of the earth, and the great advance he made was to show that the amount of dew in any night on any body depended on the power of that body to radiate heat at the time; that the more a substance was cooled by radiation, the more dew it collected, and that a body before it got dewed, was cooled by radiation to a temperature below the dew-point at the place. As to the source of the water vapour, he considered it was in the air during the heat of the day; but he admitted that some dew might rise from the ground at night. He, however, failed to prove that dew did or did not rise from the ground, and this discovery was left to another observer of our own day.

Mr. John Aitken, of Darroch, after minute observations, found that he could not accept the theory of Wells, that most of the dew was condensed out of the air near the earth's surface, and he doubted the truth of the latter's opinion as to the source of the vapour which forms the dew. He attacked the established theory in two essential points, viz., as to the formation, and as to the nature of dew. We will confine ourselves, for the present, to an explanation of the first of these points.

Mr. Aitken was aware that Le Roi, of Montpelier, had, in his treatise "*Sur la Rosée*," noticed that dew was formed *under* an inverted bell-glass as much as in any other situation. He learned from Gersten, that a plate of metal laid upon bare earth on a dewy night, remained dry on its upper surface, while being quite moist below. He studied Du Fay's perplexities, that dew appeared earlier upon bodies near the earth than upon those which were at a greater height. He noted Webster's dreamy speculations on the rising instead of the falling of dew, from the fact that the lower part of a metal plate (in consequence of its upper surface being in contact with the air and exposed to a clear sky) is colder than the earth a little below the surface, and therefore condenses the vapour. He was struck with the unvarying fact that the ground a little below the surface was warmer than the air over it, sometimes to the extent of 18° Fahr. And he concluded that, so long as the surface of the ground is above the dew-point, vapour must rise from the ground; the moist air will mingle with the superincumbent air; and its moisture will be condensed and form dew, whenever it comes in contact with a surface cooled below the dew-point.

His experiments were thus conducted. He placed a thin metal tray over grass after sunset. On dewy nights the inside was wet, and the turf under it was wetter than that not under its cover. On some nights, the dew was formed only inside; and on all nights the deposit on the inside was heavier than that on the outside. From this he concluded that far more vapour rose out of the ground during the night than condensed as dew on the grass, and that this vapour from the ground was trapped by the tray. Next, he cut from the lawn a piece of turf (six inches square and a quarter of an inch in thickness), and placed it in a shallow pan, the weight of the turf and pan being carefully noted with a sensitive balance. To prevent loss by evaporation, the weighing was done in an open shed. The turf and pan were then placed at sunset in the open cutting. Five hours afterwards, when the turf and pan were weighed, it was found that the turf had lost one hundred and forty-fifth part of its weight, and the vapour which rose from the ground during the formation of the dew accounted for this difference of weight. Making both sets of experiments on bare ground, he was even more successful, for there was more condensed vapour inside the tray which was inverted over the bare ground, than inside the one placed over grass on the same night. It is also somewhat remarkable that where the soil is thin, with a gravelly subsoil, farmers do not remove all the stones; but leave some to collect the moisture. Around pieces of iron in the field, a very marked increase of grass can be observed, owing to the deposit of moisture near them. In these cases, also, the vapour rising from the warm under-stratum is trapped by the cold surface-earth, stones, and iron. As the warm vapour rises from the heated earth it is trapped by the cold blades of grass, and dew is formed.

Mr. Aitken submitted his views to the Royal Society of Edinburgh, when they were criticised by Sir William Thomson, Professor Tait, Mr. Buchan, and Dr. Murray. These eminent authorities came to the conclusion that this new theory must take the place of the old. Since that time there has been some discussion in the *Philosophical Magazine* upon the subject, but the highest scientific authorities in this country, and on the Continent, now admit the truth of the conclusions to which Mr. Aitken has come.

The theory of Wells, that the dew falls from the air above, is therefore now untenable; and Mr. Aitken has convincingly shown the correctness of the guess of Nardius, that dew rises from the ground below.

## REVIEWS OF BOOKS.

*The Electric Motor and its Applications.* By T. C. Martin and J. Wetzler. New York: W. J. Johnston.

This is a popular book on a subject which is of rapidly-growing importance, both from a scientific and commercial point of view. It is well printed, excellently illustrated, and brings before us, in a way which must be startling to English readers who are not well acquainted with the very recent applications of electricity to motive purposes, the great and rapid strides which are being made in this important direction. This progress is particularly noticeable in the United States, where the readiness of the people to make use of any new invention or promising application, aided no doubt by favourable local conditions, has caused quite a large number of electric railways and tramways to be projected and put into operation. The action of the Americans in this matter is only another instance of their enterprise and keen perception of the useful. That it is not a case of superior inventiveness is shown by the fact that almost, or quite, all the real inventions and discoveries, and even the first practical applications, are recorded as being European. But after having brought matters to a state suitable for immediate application on this side of the Atlantic, we seem to be advancing but slowly; while on the other side the advances are being pushed forward with enthusiasm.

Besides giving an account of all the important experiments in electrical transmission of power and electric locomotion in Europe and America, there are chapters of an introductory and scientific character, interesting accounts of many ingenious schemes which ante-dated the modern dynamo-electric machine, and mainly on that account failed to obtain any success; accounts and illustrations of aerial navigation, and of "telpherage"—that ingenious system which realizes in sober earnest the old joke about sending articles by the telegraph wires—and, in fact, something about every proposed or consummated plan for making use of what has long been called "the motor of the future," but which this book shows is, to a much greater extent than is as yet understood by the general public, "the motor of the present."

*The Journal of the Iron and Steel Institute.* No 2, 1886. London: E. and F. N. Spon.

The ever-increasing bulk of the volumes comprising the Journal of this Institute may be taken as fairly representative of its growing importance and prosperity. The present issue contains, firstly, the full proceedings of the autumn meeting, which, contrary to custom, was held last year in London, no visit being made to the provinces during 1886. Eleven papers were read, and discussed at greater or less length, and everything that transpired is contained within the pages of the Journal. When one remembers that many of the highest authorities in the metallurgy of iron and steel, both from a practical or manufacturing, and scientific and theoretical point of view, take part in the meetings of the Iron and Steel Institute, it is hardly necessary to point out the value of this book. In addition to these papers and their discussions, there is the address of the then President, Dr. Percy, who alluded to many points of interest in his inaugural remarks. Amongst others were the influence of chromium on steel, a subject then beginning to attract that attention which it deserves. The mitis castings, about which so much speculation arose when they were first exhibited, a year or two ago, also gave occasion to some observations from Dr. Percy; and the remarkable effect of a very minute quantity of aluminium in an iron casting was dwelt upon in this connection. Amongst the authors of papers we find the names of Sir F. Abel, Colonel Maitland, Sir Henry Bessemer, Percy Gilchrist, Edward Riley, Frederick Siemens, and F. Gautier, besides others perhaps not quite so well known to the general public, but possessing special knowledge upon some subject of interest to the members of the Institute or the metallurgical and mechanical world at large. A supplement, or second division of the book, contains "Notes on the progress of the Home and Foreign Iron and Steel Industries." These have been culled from the various transactions and proceedings of foreign scientific societies, or foreign technical journals and publications. They appear to have been selected and edited with judgment and care, and are arranged in sections convenient for reference. On the whole, the present volume of proceedings may be said to contain much valuable matter, well presented, and to be worthy of a Society that does so much for that industry on which Great Britain's commercial importance is more than all others founded.

*Transactions of the Institution of Engineers and Shipbuilders in Scotland. Thirtieth Session*, 1886-87.

This issue of the transactions contains a further instalment of the adjourned discussion on Mr. Hector MacColl's paper on the "Shafting of Screw Steamers," a paper on "Collision Pads for the Prevention of Loss at Sea," by Mr. Richardson, and a paper on "The Education of Engineers," by Mr. Henry Dyer, M.A.

*The Watch and Clockmakers' Handbook, Dictionary, and Guide.* By F. J. Britten. London: W. Kent and Co. Price 5s.

We have received from the publishers this latest edition of Mr. Britten's well-known book. Some new features appear to have been introduced in the general arrangement of matter in order to facilitate reference. The work may be described as an encyclopedia of watch and clock making, to which has been added the French and German equivalents of the terms used. The author does not, however, confine himself to a list and description of the various parts of time-keepers, the tools and appliances used in their manufacture, etc., but gives also descriptions of some of the processes employed in the production of watches and clocks. The value of the book is much enhanced by the large number of useful engravings, and a serviceable appendix is added.

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THE Council of the Royal Society have decided that the publication of the "Philosophical Transactions" shall henceforth be in two independent series, one (*a*) containing those papers which are of a mathematical or physical character, the other (*b*) those of a biological character. The papers in each series will form a yearly volume; and that each paper shall be also issued separately in paper covers as soon as it is ready for publication.

## THE ROYAL INSTITUTION.

### THE SCIENCE OF LANGUAGE.

ON the 24th ult. Professor Max Müller delivered, at the Royal Institution, the second of his three lectures on "The Science of Language." He reminded his audience that the object of his first lecture had been to prove the simplicity of language, it being possible to build up the richest language with about 800 roots and a small number of demonstrative elements. He then proceeded to show that these 800 roots expressed really no more than about 120 fundamental concepts. Out of these every thought that had ever passed through our minds had been formed by generalization, specialization, metaphor, etc. There was nothing really new in language, but every new word had been formed from old materials, and every new thought from old concepts. *Fashionable* came from *factio*, the make or cut of a garment. *Queer* came from the German *quer*, across; *righteous* from *right*, straight; *gay* from the German *gähe*, going it; *noble* from *nobilis*, worth knowing. Whether we spoke of *peculiar* people, or of *peace* of mind, of *pagans*, or of the *propagation* of the Gospel, of a *page* of writing, or of the *Areopagus*, of *Gefngniss*, prison, or of *ein empfängliches Thor*, every one of these words sprang from the same root—*pak*, to tether, one of the 17 roots expressing the simple concept of joining or putting together. The next point was to prove the simplicity of thought by showing the identity of language and thought. Thinking, as Hobbes had shown long ago, was no more than adding and subtracting. Our judgments could be no more than either affirmative or negative. The question was, however, what we added or subtracted. We did not combine and separate things as they might or might not exist apart from us, nor our sensations, nor our precepts or presentations, nor our concepts. We could only combine and separate what we had named. We might distinguish between sensation, perception (presentation), conception, and meaning, but the four were inseparable, and they were fully realised in the process of naming only. That thought and word, *notio* and *nomen*, were thus inseparable had been the teaching of some of the most eminent philosophers. Hobbes had no doubt on the subject, while in more modern times Kircher, W. von Humboldt, Schleiermacher, Schelling, and Hegel all declared with one accord that we thought in names, and in names only. Archbishop Whateley was equally decisive on the subject, while other philosophers, such as Locke, Leibnitz, and Kant, hesitated, and, while admitting that we hardly ever thought without words, could not bring themselves to say that we never did. Berkeley looked upon words as the greatest impediments to thought, which, no doubt, they might be, and he promised in his future essays to abstain from them as much as possible, a promise which he prudently withdrew in later editions. The lecturer admitted that the belief in disembodied spirits would die hard, and protested particularly against the common expression of "mere words," which was as absurd as if we were to call an egg-shell a mere egg, or a corpse a mere man. We must be careful to define every word used by us, particularly technical terms. We need not always use them in their traditional meaning, which was generally vague, but we should clearly state how much we put into every word, and not attempt to take more out of it than we had put into it. The science of thought would thus not only mark a new departure in the history of philosophy, but would supply the only safe foundation which we wished to make honestly our own.

### BRAIN SURGERY IN THE STONE AGES.

MR. VICTOR HORSLEY gave a lecture on the 4th of March, on "Brain Surgery in the Stone Ages." The title of this discourse fairly expressed its scope, for the practice by the people of the neolithic period of resorting to surgery for the relief of mischief to the brain was fully detailed. Whatever be its explanation, the instances in which trephining was practised in the stone age occur more frequently in the centre of France than anywhere else in Europe. The deliberate nature of the operation, as exemplified in the skulls hitherto discovered, was proved by the position of the openings, their being in the majority of instances healed, and by the extremely interesting discovery of the fact that the portions of bone cut out were not only preserved as *amulets*, but also put back again into such a trephined head at the time of death. From a comparison of the modes of trephining performed by savage and mediæval nations, it was proved that the stone age people opened the skull either by drilling, scraping, or sawing, most probably by the last method. Similarly it was shown from a study of the seat of operation, that in all probability recourse to surgery was suggested by the symptoms of depressed fracture, and notably by the symptoms of traumatic epilepsy.

## ROYAL METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday evening, the 20th inst., in the Institution of Civil Engineers, 25, Great George-street, Mr. W. Ellis, F.R.A.S., president, in the chair. The following papers were read:—

(1).—"The Storm and Low Barometer of December 8th and 9th, 1886," by Mr. C. Harding, F.R. Met. Soc. The violence of this storm was felt over the whole of the British Islands, as well as over a great part of the continent of Europe. The highest wind force recorded by any anemometer over the country was a velocity of eighty miles in the hour, registered at Fleetwood. The most exceptional feature of the storm was the extraordinary low-reading of the barometer, and the long time that the mercury remained at a low level. The lowest authentic reading was 27·38ins. at Belfast, and the barometer fell below 28ins. over a great part of England, Scotland, and Ireland. At Aberdeen the mercury was below 28ins. for eighteen consecutive hours, and below 29ins. for more than sixty hours, whilst in the North of England the barometer readings were equally exceptional.

(2).—"Report of the Wind Force Committee," drawn up by Mr. G. Chatterton, M.A., F.R. Met. Soc. In this report, which is a preliminary one, the committee have dealt mainly with that portion of the investigation relating to Beaufort's Scale of Wind Force, and the equivalent velocity in miles per hour. The committee have compared the velocities as recorded by the anemographs at Holyhead, Falmouth, and Yarmouth, with the entries of Beaufort's Scale on the logs of the neighbouring lightships and lighthouses for the year 1881, and they give the results in a table. After a careful consideration of the whole of the results of this investigation, the committee are of opinion that the velocities shown by the Yarmouth anemograph, corresponding to Beaufort's Scale as recorded on board the lightships, are too high, and that the velocities shewn by the Falmouth anemograph are probably too low. The committee, however, have not yet had before them sufficient data to determine with any degree of certainty the relation between Beaufort's Scale of Wind Force, and the equivalent velocity in miles per hour. Neither are they able to recommend any existing scale that can be adopted or modified.

(3).—"A new form of Velocity Anemometer," by Mr. W. H. Dines, B.A., F.R. Met. Soc. In this instrument an attempt has been made to measure the velocity of the wind by the rotation of a small pair of windmill sails, the pitch of the sails being altered automatically, so that the rate may always bear the same ratio to that of the wind. The mechanical details are briefly as follows:—A helicoid is fixed at the front, and a small pair of sails of variable pitch at the back of a steel rod, and just behind the helicoid a light fan, which can turn on the same axis, but is independent of the helicoid and sails. If the rotation be too rapid, the fan turns in the same direction as the helicoid, and by its motion alters the pitch of the sails so that their motion is retarded; if, on the other hand, the friction is increased, or from any other cause the motion becomes too slow, the fan is turned in the other direction, and the rate is increased. The motion is communicated to a vertical rod, which passes down the hollow pivot on which the instrument turns; it is kept facing the wind by a vane. It is convenient to connect the vertical shaft to the recording dial by a light flexible wire, all that is necessary being to place the dial approximately beneath the anemometer; by this means the trouble of ascending a high tower or ladder is avoided, except where oil is required.

(4).—"Description of two New Maximum Pressure Registering Anemometers," by Mr. G. M. Whipple, B.Sc., F.R. Met. Soc. The simplest instrument is a modification of the Lind's, Hagemann's or Pitot's water-pressure anemometers, provided with an apparatus for registering the maximum height the water attained during the period which elapsed since the last setting of the instrument. The second form of registering maximum pressure anemometer is derived from the ordinary pressure plate instrument; a circular metallic disc of 9⅝ins. in diameter exposing a surface of half a square foot is kept at right angles to the wind by means of a suitable vane. This disc is perforated by eight circular apertures, each of 1⅝in. in diameter. Behind each aperture a disc of 1¾in. in diameter is loosely held *in situ* by means of a bent lever loaded with a weight. These weights are arranged so as to press upon the different discs with pressures proportionate to the values usually assigned to wind-pressures measured by the various degrees of the Beaufort Scale.

## THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 5th of April, a paper was read on "Printing Machinery," by Mr. E. A. Clowes. The author commenced by stating that in the middle of the fifteenth century, printers possessed an appliance which would print on one side of a sheet of foolscap only; and at the present time they have an apparatus that prints on both sides simultaneously from reels of paper five miles long at the rate of 100 yards per minute. The former worked at the rate of less than 200 impressions per hour; the latter gives 10,000 copies of *The Times* per hour.

The earliest representation of a press is dated 1507. There is a simple screw, with a long pin for a lever. The wonderful degree to which the apparatus of printing has been rendered automatic is shown by a Table, from which it appears that to print a single sheet by the hand-press ten separate and distinct operations are necessary; on an ordinary cylinder machine with flyers these are reduced to two, while in a rotary web-machine the whole operation is performed by the self-acting mechanism.

After referring to early inventions, at some length, the author went on to describe the construction of the Walter web-printing-press, undertaken in 1862 by Mr. John Cameron MacDonald, the present Manager of *The Times*, aided by Mr. Joseph Calverly, the chief engineer. This press is about 19 feet long, 6 feet wide, and 7 feet high. Each roll used in printing *The Times* is about 8,000 yards in length, and weighs 800 lbs. The paper is passed from the roll over hollow damping-cylinders perforated with small holes, through which steam condenses on the blanket-covering, by which it becomes thoroughly wetted on both sides. The paper is then squeezed and goes to the printing appliances, consisting of four large cylinders, arranged one above the other. The two outside carry the stereotype-plates, while the two in the middle are the pressing-cylinders. The paper, after passing between the rollers, is led between the upper printing and pressing-cylinders, when one side of it is printed upon; it is then passed between the two pressing-cylinders, and afterwards between the lower-pressing and lower printing-cylinders, when it receives an impression upon the other side. Provision is made for taking up the set-off by means of a metal cylinder pressing against the lower impression-cylinder, and licking up the superfluous ink on the covering thereof, while any accumulation of set-off is prevented by a rubbing-bar affixed to its circumference. After having been printed on both sides, the paper passes to the cutting-cylinders. The machinery is so adjusted that a knife catches the paper exactly between the sheets, and, the paper being held hard on each side by a spring-bar, cuts it in two, all but a couple of tags near each end, which are left for the purpose of pulling the sheet on between two sets of running tapes, until it is caught by a pair of small rollers, which are driven at a greater speed than the rest of the machine. These immediately tear the sheets apart where they had been all but separated, and the tapes hurry on the complete newspaper until a frame, like a huge comb, flings it down on a board. All the manual labour required is supplied by two boys, and a man, who attends to the machine. Folding apparatus has been applied without entailing any diminution of speed, which is about 10,000 perfect copies of the eight-page paper per hour.

The Walter Press may be regarded as, in the main, the type of subsequent web-rotary machines, which differ from it but in accessories. The "Victory," its chief rival, was brought out in 1870. It gained favour among country newspaper proprietors for its being cheaper in price, and possessing folding arrangements, an important feature in places where the newsvendors require to receive their copies ready folded. In 1873, Messrs. Hoe, of New York, introduced a rotary machine, which claimed a speed of fourteen thousand perfect sheets per hour.

The culminating point in regard to speed has, so far, been attained by Messrs. Hoe, of New York, the most recent of whose machines seem altogether fabulous in the extent of their output. One prints and delivers folded an eight-page paper like *The Standard* at the speed of twenty-five thousand per hour. Another prints eight, ten, or twelve-page papers, delivering them folded, to either half-page or quarter-page size at the rate of twenty-five thousand per hour. For ten-page and twelve-page papers, the inset of two or four pages is printed on a supplementary machine inside, and is then directed to and folded with the main web of paper, And another prints eight-page newspapers, delivering them folded to either half or quarter-page size, at the rate of eleven thousand per hour. It also delivers two, four, eight, or sixteen-page sheets unfolded. A four-page paper like *The Echo* would be turned out completely printed on both sides, at the rate of nearly fifty thousand per hour by this apparatus.

## THE PHYSICAL SOCIETY.

At a recent meeting of the Physical Society, Professors Perry and Ayrton read a note on "Magnetic Resistance." Two iron rings about 6in. diameter, made from the same bar of best Swedish iron about ½in. diameter, were wound with insulated wire in two halves, so that a current could be sent round either or both halves, and the resulting induction measured by the throw of a ballistic galvanometer placed in series with a few convolutions of wire wound round the outside of the main winding. One of the rings was continuous, and the other had a small air space of about ·8 mm. in a plane perpendicular to that of the ring and passing through its axis, as if the ring had been cut by a saw. The primary object of the experiments which were made by Messrs. Aldworth, Dykes, Lamb, Robertson, and Zingler, of the Central Institution, was to determine whether there was any appreciable "surface magnetic resistance." The results do not show any such resistance, and the relative resistance of air and iron as calculated from the unsaturated parts are about as 1200 to 1, a number agreeing fairly well with those obtained by other experimenters. From this the authors conclude that for small distances magnetic resistance of air is proportional to length. When the magnetising current was passed round the one-half of the divided ring on which the test coil was wound a greater induction could be obtained than by any other way of magnetising, and this the authors do not attempt to explain.

## FINSBURY TECHNICAL COLLEGE.

A MEETING of the Old Students' Association was held on March 23rd, at the College, when Mr. Bertram Chatterton read an exhaustive paper on "Hydraulic Motors." The discussion that followed was supported by Messrs. Humphreys, Webb, Pettigrew, A. Chatterton, and others. The chief interest appeared to centre in the advantages the lecturer had claimed for hydraulic motors over electrical motors, and it was agreed on all sides that while for extremely heavy work water-power was unrivalled, it was quite out of the field for lighter work requiring, say, only one or two horse-power.

THE INSTITUTION OF NAVAL ARCHITECTS.—The spring meeting of the Institution was held this year somewhat earlier than usual, taking place on the two final days of March and the 1st of April. At one time it was feared that the meeting would be short of the usual average of excellency attained by the gatherings of this flourishing and excellently-conducted institution. The death of Mr. William Denny, of Dumbarton, so prominent and popular a member, not only deprived the executive of his help, but cast a gloom over the deliberations of the Council. There was also at first somewhat a dearth of good papers, and the long-continued depression in the ship-building industry did not promise well for good attendances. In spite of these discouraging circumstances, the meeting was, on the whole, fairly successful. The attendance was fair, the papers fair, and the discussions not below the average.

The chief event of the meeting was undoubtedly the paper contributed by Mr. Biles, the chief of the constructive department at Messrs. J. and G. Thomson's important shipyard, at Clyde Bank. Mr. Biles chose for his subject the question of internal *v.* external protection for ships of war. The problem is one which is exercising the minds of naval constructors and naval officers to a considerable extent just at present; and, it is needless to say, is of the greatest national importance. As a general rule, it may be said that naval constructors, *i.e.*, professional ship designers, are more favourably disposed towards internal protection than outside armour, the notable exception being Sir Edward Reed. On the other hand, a great majority of naval officers, who are the men perhaps most directly interested in the matter, cast their vote in favour of outside armour in the shape of a water-line belt. The question is one of so complicated a nature, that we may safely say it will never be settled until we have practical data, obtained from actual warfare, to go upon.

Another paper of importance was Sir Nathaniel Burnaby's contribution on "The Fuel Supply of Warships," the reading of which gave the late chief of naval construction an opportunity of answering those who had been attacking him on the question of increased draught of the *Warspite* and *Imperieuse*. It was not a very difficult task, for Sir Nathaniel had only to show that it is possible to overload any vessel so as to bring her below the water line designed. Another paper by the same author was on "The Merchant Service and the Royal Navy." Mr. J. H. Biles described two large sea-going torpedo vessels, built by Messrs. Thomson for foreign governments. Mr. Dixon Kemp read a very interesting paper on "Yachts," and Mr. Spyer, of the Admiralty, gave details of the machinery used in the small steamboats of the Royal Navy. The chief of the more strictly scientific papers was read by Professor Cotterill, and referred to the influence of the action of a screw propeller on the water-line. Mr. Calvert also gave details of some very ingenious experiments he had devised to determine the forces acting on the blade of a screw propeller. The summer meeting will be held during the last week in July at Newcastle-on-Tyne, where the president, Lord Ravensworth, promised all those who would attend a hearty welcome. An invitation was also sent from Sunderland, and visits to that town will form a feature in the proceedings.

THE ROYAL INSTITUTION.—The following arrangements for the lectures have been announced:—John Hopkinson, Esq., M.A., D.Sc., F.R.S., B.S., M. Inst. C.E., M.R.I., four lectures on "Electricity," on Tuesdays, April 26, May 3, 10. Victor Horsley, Esq., F.R.S., B.S., F.R.C.S., three lectures on "The Modern Physiology of the Brain and its Relation to the Mind," on Tuesdays, May 17, 24, 31. The Rev. J. P. Mahaffy, D.D., Professor of Ancient History in the University of Dublin, three lectures on "The Hellenism of Alexander's Empire": Lecture I., on Tuesday, June 7, "Macedonia and Greece"; lecture II., on Thursday, June 9, "Egypt"; lecture III., on Saturday, June 11, "Syria." Professor Dewar, M.A., F.R.S., M.R.I., Fullerian Professor of Chemistry, R.I., seven lectures on "The Chemistry of the Organic World"; on Thursdays, April 21, 28, May 5, 12, 19, 26, June 2. R. von Lendenfeld, Esq., Ph.D., three lectures on "Recent Scientific Researches in Australasia"; on Saturdays, April 23, 30, May 7. John W. Hales, Esq., M.A., four lectures on "Victorian Literature"; on Saturdays, May 14, 21, 28, June 4.

## RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.

*** *The whole of the papers of the Societies referred to are not included in this list.*

### THE ROYAL SOCIETY.

Mar. 21st.—Papers read, "On Ice and Brine," by Mr. J. Y. Buchanan; "On the Distribution of Temperature in the Antarctic Ocean," by Mr. J. Y. Buchanan, ; "The Sense of Smell," Part III., by Professor Haycraft.

Mar. 24th.—Papers read, "Preliminary Note on the Radio-Micrometer —a New Instrument for Measuring the most feeble Radiation," by Mr. C. V. Boys; "Note to a Memoir on the Theory of Mathematical Form," by Mr. A. B. Kempe; "On Ellipsordial Current Sheets," by Professor H. Lamb; "On the Magnetisation of Iron in Strong Fields," by Professor J. A. Ewing and Mr. W. Low.

Mar. 31st.—Papers read, "Note on the Development of Voltaic Electricity by Atmospheric Oxidation," by Dr. Alder Wright and Mr. C. Thompson; "On Clausin's Formula for the Change of State from Liquid to Gas applied to Messrs. Ramsay and Young's Observations," by Professor Fitzgerald; "The Influence of Stress and Strain on the Physical Properties of Matter," Part III.; "Magnetic Induction," by Mr. H. Tomlinson.

April 21st.—Papers read, "On Phosphonium Chloride," by Mr. S. Skinner; "On the Principal Electric Time-Constant of a Circular Disc," by Professor H. Lamb; "Conduction of Heat in Liquids," by Mr. C. Chree.

### THE ROYAL INSTITUTION OF GREAT BRITAIN.

April 1st.—Paper read, "Light as an Analytic Agent," by Professor Dewar, M.A., F.R.S., M.R.I.

April 2nd.—Lecture, "The Science of Thought," by Professor Max Müller.

April 19th.—Lecture. "Electricity," by Mr. J. Hopkinson, M.A., D.Sc.

April 22nd.—Paper read, "The Work of the Imperial Institute," by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I.

April 29th.—Paper read, "The Rolling Contact of Bodies," by Professor H. S. Hele Shaw.

### THE SOCIETY OF ARTS.

Mar. 21st and 28th, and April 4th.—Cantor Lectures, Nos. 1, 2, and 3; "Machines for Testing Materials, especially Iron and Steel," by Professor W. C. Unwin.

March 23rd.—Paper read, "Some of the Conditions Affecting the Distribution of Micro-Organisms in the Atmosphere," by Dr. P. Frankland.

Mar. 25th.—Paper read, "Indian Coffee," by Mr. F. Clifford.

April 19th.—Paper read, "South Africa," by Major-General Sir Charles Warren.

April 20th.—Paper read, "Electric Locomotion," by Mr. A. Reckenzaun.

### ROYAL DUBLIN SOCIETY.

Mar. 23rd.—Papers read, "On Sources of Light for Projection," by Professor W. F. Barrett; "On the Cause of Iridescence in Clouds," continued by Mr. S. Johnstone Stoney; "Analysis of the Beryls of Glencullen, Co. Wicklow," by Professor W. N. Hartley; "On Specimens of Granite from Galway," by Mr. G. H. Kinahan, M.R.I.A.; "On the Ruby Mines of Burmah," by Mr. V. Ball; "Note on Submerged Peat Mosses and Trees in certain Lakes in Connaught," by Mr. A. B. Wynne; "Lisbellaw Conglomerate, Co. Fermanagh and Chesil Bank, Dorsetshire," by Mr. G. H. Kinahan; "Economic Geology in Ireland—Sands and Sandstones," by Mr. G. H. Kinahan; "Observations on Professor Suess's Statements regarding the Level of the Ocean Surface," by Professor E. Hull.

April 20th.—Papers read, "A Mechanical Method of Solving Problems in Spherical Trigonometry," by Mr. A. A. Rambant; "Notes on Recent Embryological Researches," by Professor A. C. Haddon; "Deal Timber in the Lake Basins and Peat Bogs of North-East Donegal," by Mr. G. H. Kinahan.

### ROYAL SCOTTISH SOCIETY OF ARTS.

Mar. 28.—"Report on Mackenzie's Sketching Protractor;" "Report on Mr. Turnbull's Gas Process;" "Notes on some of the large Engineering Works of the Century" (First Series: The Suez Canal), by Mr. Wm. A. Carter.

April 11.—"Report on Mr. Pollitt's Mirror Level;" "A Technical Aspect of Stained Glass," by Mr. O. Paterson; "Economical Meteorology," by Mr. A. Frazer; "Proposed Method of Graduating Barometers," by Mr. A. Frazer.

### THE INSTITUTION OF CIVIL ENGINEERS.

April 5.—Paper read, "Printing Machinery," by Mr. E. A. Clowes.

April 15.—Paper read, "Water-Supply from Wells," by Messrs. Grover, Fox, Stooke, and Matthews.

STUDENTS' MEETINGS.

April 1.—Paper read, "Hydraulic Appliances at the Forth Bridge Works," by Mr. E. W. Moir, Stud.Inst.C.E.

April 15.—Paper read, "Experiments on Iron and Steel in Tension, Torsion, and Shear," by Messrs. R. F. Hayward and J. Platt, Students Inst.C.E.

### INSTITUTION OF NAVAL ARCHITECTS.

March 30.—Papers read, "The Merchant Service and the Royal Navy," by Sir Nathaniel Barnaby; "Torpedo Boat Trials," by M. de Bussy; "Twin Screw Torpedo Boats," by Mr. J. H. Biles.

March 31.—Papers read, "English and American Yachts," by Mr. Dixon Kemp; "The Corrosion of Iron and Steel Ships, and their Protection," by Mr. V. B. Lewes; "Fuel Supply in Ships of War," by Sir N. Barnaby; "Changes of Level in Water surrounding a Vessel," by Prof. J. H. Cotterill; "The Forces acting on the Blade of a Screw Propellor," by Mr. G. A. Calvert; "On the Machinery of Small Steamboats," by Mr. A. Spayer.

April 1.—Papers read, "Side and Internal Armour of Cruisers," by Mr. J. H. Biles; "On the Shifting of Cargoes," by Prof. P. Jenkins; "The Application of Stability Calculations," by Mr. A. Denny; "An Hydraulic Apparatus for Transmitting Signals," by Mr. E. Widmann; "High-Speed Twin Screws," by Mr. E. A. Linnington; "Paper Sections for Cross Curves of Stability," by Mr. J. H. Heck; "Stability Calculations by the Planimeter," by Mr. L. Benjamin.

### CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

Jan. 5.—Paper read, "On the Treatment of Sewage at Wimbledon," by Mr. C. H. Cooper.

Jan. 19.—Paper read, "The Design of Iron Bridges," by Mr. Francis Campin.

Feb. 2.—Paper read, "House Drainage," by Mr. W. Lee Beardmore.

Feb. 16.—Paper read, "Reservoir Dams," by Mr. D. Gravell.

Mar. 2.—Paper read, "Wave Percussion," by Mr. B. Haughton.

Mar. 16.—Paper read, "Rural Sanitary Authorities," by Mr. H. D. Appleton.

Mar. 30.—Paper read, "Methods of Boring for Petroleum in Galicia," by Mr. R. V. Boyd.

April 13.—Paper read, "The Forth Bridge," by Mr. R. E. Middleton.

April 27.—Paper read, "The Use and Care of Chains for Lifting and Hauling," by Mr. H. Adams.

### ROYAL METEOROLOGICAL SOCIETY.

April 20.—Papers read, "The Storm and Low Barometer of December 8th and 9th, 1886," by Mr. C. Harding; "Report of the Wind Force Committee," by Mr. G. Chatterton; "A New Form of Velocity Anemometer," by Mr. W. H. Dines; "Description of Two Maximum Pressure Registering Anemometers," by Mr. G. M. Whipple.

### JUNIOR ENGINEERING SOCIETY.

Mar. 25.—Paper read, "Torpedo Boats and Machinery," by Mr. W. C C. Smith.

### SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

Mar. 24.—Paper read, "Resistance of Faults in Submarine Cables," by Mr. A. E. Kennelly.

### GEOLOGICAL SOCIETY.

Mar. 23.—Papers read, "Notes on Some of the Older Rocks of Brittany," by Mr. T. G. Bonney; "The Rocks of Sark, Herm, and Jethon," by Rev. E. Hill.

April 6.—Papers read, "On the Rocks of the Malvern Hills," Part II., by Mr. F. Rutley; "On the Alleged Conversion of Crystalline Schists into Igneous Rocks," by Mr. C. Callaway; "A Preliminary Inquiry into the Genesis of the Crystalline Schists of the Malvern Hills," by Mr. C. Callaway.

### SOCIETY OF CHEMICAL INDUSTRY.

April 4.—Paper read, "Further Notes and Experiments on the Composition and Manurial Value of Filter-pressed Sewage Sludge," by Dr. J. M. H. Munro.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

3696.—CHARLES BERRY PHILLIPS, Carlton Terrace, Chester. "Dephosphorating and refining iron, steel, alloys of iron or steel and other metals and alloys." 11th March, 1887.

3744.—JOHN RICHARDSON and BARTHOLOMEW RICHMOND ROWLAND, 166, Fleet Street, London. "Valve gear of steam engines." 11th March, 1887.

3811.—THOMAS ROWE WESTON, 131, St. Thomas Road, Finsbury Park, London. "Obtaining electricity." 14th March, 1887.

3831.—FREDERICK CARRINGTON PHILLIPS and HUGH ERAT HARRISON, 2, Victoria Mansions, Victoria Street, Westminster, S.W. "Transforming alternating electric currents into other alternating currents." 14th March, 1887.

3914.—ALFRED JULIUS BOULT, 323, High Holborn, Middlesex. A communication from James F. McLaughlin, United States. "Despatch tube systems." (Complete specification.) 15th March, 1887.

3915.—ALFRED JULIUS BOULT, 323, High Holborn, Middlesex. A communication from James F. McLaughlin, United States. "Carriers for pneumatic despatch tube systems." (Complete specification.) 15th March, 1887.

3917.—CHARLES WITTENBERG, 323, High Holborn, W.C. "Telephone registers." (Complete specification.) 15th March, 1887.

3920.—ALFRED JULIUS BOULT, 323, High Holborn, Middlesex. A communication from Louis Bagger, United States. "Igniting explosive charges." (Complete specification.) 15th March, 1887.

3933.—THORSTEN NORDENFELT, 24, Southampton Buildings, London, "Electric signalling instruments, suitable for ships' telegraphs." 15th March, 1887.

3943.—WILLIAM HENRY DOUGLAS, 4 and 5, Arcade Chambers, Corporation Street, Birmingham. "Instruments for measuring electric currents." 16th March, 1887.

3947.—HUGH CAMPBELL, Commercial Street, Halifax. "Gas motor engines." 16th March, 1887.

3960.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Arthur M. Phelps, United States. "Telephones." (Complete specification.) 16th March, 1887.

3988.—WILLIAM DONALDSON, 2, Westminster Chambers, Victoria Street, Westminster. "Fluid pressure motor." 16th March, 1887.

3989.—PETER BROTHERHOOD, 28, Southampton Buildings, London. "Three cylinder engines." (Complete specification.) 16th March, 1887.

3990.—CHARLES CLAMOND, 28, Southampton Buildings, London. "Micro-telephonic transmitters." 16th March, 1887.

4022.—CHARLES HUMFREY, 6, Lord Street, Liverpool. "Manufacture or sodium." 17th March, 1887.

4032.—MORITZ IMMISCH, 52, Chancery Lane, London. "Holder for brushes of electro-motors and dynamo-machines." 17th March, 1887.

4055.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Carl Dornbusch, Saxony. "Weighing machines." 17th March, 1887.

4088.—GEORGE MILLIGAN, 67, Walton Street, Oxford. "Obtaining aluminate of soda from clay and soda salts." 18th March, 1887.

4111.—ROBERT SAMUEL LLOYD, of the firm of Hayward, Tyler and Co., 77, Chancery Lane, London. "Hot air engines." 18th March, 1877.

4126.—MYRTHIL BERNARD and ERNEST BERNARD, 4, South Street, Finsbury, London. "Process for the electrolysis of certain double chlorides." 18th March, 1887.

4199.—ARTHUR BRIN and LEON QUENTIN BRIN, 69, Horseferry Road, Westminster. "Production of chlorine and hydrogen." 21st March, 1887.

4228.—CURT NETTO, 45, Southampton Buildings, London. "Extraction of aluminium from substances containing the same." 21st March, 1887.

4279.—HENRY WATSON, HENRY BURNET WATSON, and JOHN STANLEY WATSON, High Bridge Works, Newcastle-on-Tyne. "Ventilating valves." 22nd March, 1887.

4280.—FREDERICK CASSE, at present of 59, Guildford Street, Russell Square, London. "Inexplosive steam boiler." 22nd March. 1887.

4319.—JOSEPH DEVONPORT FINNEY ANDREWS, 28, Southampton Buildings, London. "Single-acting engines." 22nd March, 1887.

4320.—HIRAM STEVENS MAXIM, 45, Southampton Buildings, London. "Manufacture of guns." 22nd March, 1887.

4322.—JOHN HOPKINSON and EDWARD HOPKINSON, 47, Lincoln's Inn Fields, London. "Dynamo electric machines." 22nd March, 1887.

4362.—WILLIAM GASKELL, 8, Quality Court, London. "Preventing smoke and economising fuel in steam boiler furnaces." 23rd March, 1887.

4373.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from August Berghausen, Germany. "Automatic signalling apparatus for the detection of fire damp." 23rd March, 1887.

4375.—HULDA WEBER and RUPERT SCHEFBAUER, 8, Quality Court, London. "Insulating electrical conductors or wires." (Complete specification.) 23rd March, 1887.

4403.—JAMES MACEWAN ROSS and JAMES MCDOWALL, 62, St. Vincent Street, Glasgow. "Rotary engines and pumps." 24th March, 1887.

4423.—JAMES RODGER THOMSON, of the firm of James and George Thomson, and JOHN HARWARD BILES, 62, St. Vincent Street, Glasgow. "Boilers for steam ships." Complete specification.) 24th March, 1887.

4460.—THOMAS PARKER, 70, Market Steeet, Manchester. "Electro-dynamic and dynamo-electric machines." 25th March, 1887.

4472.—SILVANUS PHILLIPS THOMPSON, 323, High Holborn, London. "Electro-deposition of cobalt." 25th March, 1887.

4494.—HENRY NURSE, 1, Queen Victoria Street, London. "Steam generators." 25th March, 1887.

4553.—WILLIAM DICKENSON, 24, Southampton Buildings, London. "Electric telegraph apparatus." 26th March, 1887.

4576.—DESIRE GUILLAUME REILTON, SEBASTIEN TOUSSAINT MONTAGNE and OLIVER LOUIS BENJAMIN LEPREVOST BOURGEREL, 1, Rue Lafitte, Paris. "Extracting aluminium from alumina." (Complete specification.) 28th March, 1887.

4664.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from Eugen Hutchinson Cowles and Alfred Hutchinson Cowles, United States. "Electric furnaces, applicable for making aluminium and for other purposes." (Complete specification.) 29th March, 1887.

4667.—WILLIAM PRESCOTT KOOKOGEY, 323, High Holborn, London. "Galvanic battery solutions." (Complete specification.) 29th March, 1887.

4692.—ROBERT LUKE HOWARD, ELIOT HOWARD, and ROBERT SAMUEL LLOYD, all of the firm of Hayward, Tyler, and Co., 77, Chancery Lane, London. "Hot-air engines." 29th March, 1887.

4823.—CHARLES HENRY CATHCART, 8, Quality Court, London. "Galvanic Battery." 31st March, 1887.

4824.—OWEN CHARLES DALHOUSIE ROSS, 8, Quality Court, London. "Generating electro-magnetic currents." 31st March, 1887.

4978.—FREDERICK THOMAS SCHMIDT, Sunbridge Chambers, Bradford. "Holder and switch for electric lamps." 4th April, 1887.

4993.—WILLIAM HICHENS RICKARD and THOMAS JOHN RICKARD, Trelawney House, Caerleon Road, Maindel, Newport, Monmouthshire. "Coating plates with tin, lead, and other metal, or alloys of same." 4th April, 1887.

5009.—JAMES TARBOTTON ARMSTRONG, 8, Quality Court, London. "Charging, re-charging, cleansing, changing, and varying the chemicals and liquids used in secondary batteries." 4th April, 1887.

5010.—The Honourable RICHARD CLERE PARSONS, 28, Southampton Buildings, Chancery Lane, London. "Multiple cylinder engines." 4th April, 1887.

5039.—WILLIAM BRYER NATION and JOHN JOSEPH WORSWICK, 8, Quality Court, Chancery Lane, London. "Application of electricity to the treatment of vegetable fibres, suitable for spinning, weaving, and other analogous purposes." 5th April, 1887.

5046.—JOSEPH MARIE ACHILLE FOURNIER, 74, St. Stephen's Avenue, Shepherd's Bush, London. "Purifying, heating, and burning illuminating gas." 5th April, 1887.

5052.—EYRE CROWE, 31, South Bar, Banbury. "Hydro-carbon engines." 5th April, 1887.

5122.—GEORGE EDENSOR DORMAN, Brook House, Stafford. "Thermo-electric elements." 6th April, 1887.

5186.—ALEXANDER PELHAM TROTTER and WALTER THOMAS GOOLDEN, 23, Andalus Road, Clapham, London. "Brush-holders for dynamo-electric machines." 7th April, 1887.

5193.—GEORGE ANNESLEY GRINDLE, 79, Cambridge Gardens, Notting Hill, London. "System of generation and distribution of electricity." 7th April, 1887.

# Scientific News

## FOR GENERAL READERS.

Vol. I.] June, 1887. [No. 4.

CONTENTS.



## CURRENT EVENTS.

Science, Art, and Literature.—Professor Huxley, with great felicity of expression, made some useful and suggestive remarks at the Royal Academy banquet. "I imagine," he said, "that it is the business of the artist and of the man of letters to reproduce and fix forms of imagination to which the mind will afterwards recur with pleasure; so, based upon the same great principle by the same instinct, if I may so call it, it is the business of the man of science to symbolize, and fix, and represent to our mind in some easily recallable shape, the order, and the symmetry, and the beauty that prevail throughout Nature. I am not sure that any of us can go much further from the one to the other. We speak in symbols. The artist places his colours upon the wall; the colours have no relation to the actual objects, but they serve their purpose in recalling the emotions which were present when the scenes which they depict were acted. I am not at all sure that the conceptions of science have much more correspondence with reality than the colours of the artist have; but they are the symbols by which we are constantly recalling the order and beauty of Nature, and by which we by degrees force our way further and further into her penetralia, acquiring a greater insight into the mystery and wonder which are around us, and at the same time, by a happy chance, contributing to the happiness and prosperity of mankind."

He is of opinion that the great truth, that art, and literature, and science are one, and that the foundation of every sound education and preparation for active life, in which a special education is necessary, should be some efficient training in all three. Recognising that the three branches of art, science, and literature, are essential to the making of a man, to the development of something better than the mere specialist in any one of these departments, he concluded as follows:—"I sincerely trust that that spirit may in course of time permeate the mass of the people, that we may at length have for our young people an education which will train them in all three branches, which will enable them to understand the beauties of art, to comprehend the literature at any rate of their own country, and to take such interest not in the mere acquisition of science, but in the methods of inductive logic and scientific inquiry as will make them equally fit for whatever specialised pursuit they may afterwards take up. I see great changes; I see science acquiring a position which it was almost hopeless to think she could acquire. I am perfectly easy as to the future fate of scientific knowledge and scientific training; what I do fear is, that it may be possible that we should neglect those other sides of the human mind, and that the tendency to inroads which is already marked may become increased by the lack of the general training of early youth to which I have referred."

The Manchester Jubilee Exhibition.—Opinions may differ as to the desirability of having so many exhibitions in a single year, but there can be no doubt that of the one recently opened by the Prince and Princess of Wales, not only Manchester, but the whole of England, may be justly proud. We do not mean that there are many startling novelties or new departures in the exhibits, but that the average merit is decidedly high, while the extent and variety of the exhibition are very striking. We have not the space at our disposal to describe exhibits in detail, moreover they are being exhaustively treated in the technical and professional journals, but we may say in general terms that the display of textile and other machinery in motion has seldom, if ever, been equalled in this country. We are also greatly struck with the very simple and ingenious manner in which the building itself is constructed. Nearly the whole of the framing for the roof is made of ordinary pipes and tubes, so that not only has the first cost been moderate, but, when the exhibition is over, the pipes can be disconnected and sold with a minimum of loss.

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The chemical section also reflects great credit on its many supporters, and the intelligent arrangement in groups and classes helps the visitor very much to compare the products of competing makers. The number and variety of dye-materials and other chemicals used in the textile industries is very noticeable, and among the exhibits of chemical research, Mr. Perkin (the discoverer of the first coal-tar colour and the originator of the coal-tar colour industry) appropriately shows specimens illustrating the discovery of mauve, the first aniline dye. In the metallurgical group there are some interesting specimens of steel and slag made from phosphoric pig-iron by the basic process, and in the other groups there are many instructive exhibits, some of which we have described elsewhere. The Cowles Electric Smelting and Aluminium Company show sample ingots made in an electric smelting-furnace, such as was fully described in our last number. Messrs. Spence and Sons make a great display, and among other things show a colossal mass of alum crystals, said to weigh over ten and a quarter tons.

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Infected Milk.—The Local Government Board have issued the report of Mr. W. H. Power, on the recent outbreak of diphtheria at Yorktown and Camberley, and although it throws a good deal of light on the conditions which affect the capability of milk to produce disease, we regret to find that his investigation failed to discover how the milk acquired its infective property. Mr. Power appears satisfied that the infection was not due to the drainage, water supply, or deposits of river mud. With regard to the milk being infected, he bases his opinion chiefly on the fact that in an area containing 176 houses, 94 of which received milk from the infected farm, and 82 of which derived their supply from other sources, 48 of the former and only 9 of the latter were attacked by diphtheria or throat affections, and some of the inmates of the 9 houses had either been exposed to infection from other cases of diphtheria, or had consumed some of the suspected milk. We may not know how milk becomes infected, but we do know that it is capable of being infected, and that the risk arising from drinking it may be greatly reduced if not entirely removed by boiling it. The precaution is a simple one, and yet how few avail themselves of it.

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Technical Education.—Under the presidency of Professor Huxley, F.R.S., a meeting of many leading advocates of technical education was held at the house of Mr. E. C. Robins, the representative of the Dyers' Company on the executive committee of the City and Guilds of London Institute. The chief event was an address by Professor Ayrton, F.R.S., on *The Technical Training at the Central Institution,* an abstract of which will be found elsewhere. Before the address Mr. Robins briefly explained the object of the meeting, and mentioned that the Institute had founded three institutions in London, viz., the Kennington Applied Art School, in the South; the Finsbury Technical College, or School of Applied Science and Art, with evening trade classes in the East; and the Central Institution at South Kensington in the West. He added that the Finsbury College, with 1,200 students, was now full to overflowing, and was about to be enlarged.

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At the close of the meeting, Professor Huxley remarked that the excellent and vigorous school which the City and Guilds Institute had established at Finsbury was chiefly intended to give primary technical instruction to workmen and others who could snatch only a few hours a week from their daily labour for the purpose of receiving it. The Central Institution, on the other hand, was chiefly intended for the advanced instruction of persons who could give up their time for one or more years to the higher branches of technology. Exhibitions enabled the promising student of the schools at Finsbury and elsewhere to pass to the Central Institution, and profit by the advantages it offered him.

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Professor Huxley further remarked that much had been said about the cost of the Central Institution, but that if in the course of the next few years the Institute succeeded in catching and training another Faraday, or Whitworth, or Armstrong, it would, from a mere commercial point of view, be worth all the expenditure, initial and assured. This organisation was, in fact, a capacity-catching apparatus. No blue blood was recognisable among Englishmen, and there was no reason to suppose that ten thousand men taken at random out of one stratum of our population would have more or less chance of containing a mechanical genius than ten thousand taken from any other stratum. The future of the country depended, in industries as in every other pursuit, on bringing our capacities to the top, and if possible sending our incapacities to the bottom. He considered that the organisation of the City and Guilds Institute had been thoroughly and consistently worked without thought of toil or cost, and would be one of the most efficient means to that desirable end.

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The Detection of Fraudulent Bank Notes.—*La Science en Famille* gives an interesting account of the system of numbering the notes issued by the Banque de France, and of several methods used for detecting fraudulent notes. A very simple test is made by comparing a doubtful note with a genuine one in the stereoscope. If the two notes appear as one they may both be assumed to be genuine, but if they have not been printed from the same plate the lettering and figures will not exactly correspond, and the false note will be detected. Even with the best possible imitation, the shape and position of the letters, and many other little details will always have small differences, and in the stereoscope they can be seen distinctly. There is also this further advantage, that although the imitator may find out flaws in the false note he has made, he is not in the least helped to find means of correcting his mistakes, or of making his productions more perfect. This method can also be used for testing bills of exchange, share certificates, old prints, and many other objects of value.

The Perception of Colours.—Recently in America, a man claimed damages for an alleged loss of sight in his left eye, owing to an accident. The eye had a thoroughly healthy appearance, and an oculist who examined it pronounced it to be perfectly sound. To prove this he made the following test, which is based on the fact when green and red rays are mixed they give black. Some words were written in green ink on a black card, and the man who said that his sight was injured was made to look through spectacles, in which the right-hand glass was red and the left glass was plain. He was able to read what was written quite clearly, and this proved his deception, because with the right eye it would have been impossible to make out green letters on a black ground.

A Deep Boring.—The American Congress has recently voted one hundred thousand dollars for the purpose of boring a deep hole in the earth. This hole is to be the deepest yet made, and the boring will be superintended by the Engineer Corps of the U.S. army. The experiment will be watched with the greatest interest, not only on account of the information it will yield about the structure of the earth's crust, but also in connection with the more important subject of tapping the earth's internal stores of heat for practical purposes.

Action of Beverages on Digestion.—Dr. James W. Fraser has lately published the results of an interesting series of experiments on the influence of some of our common beverages on digestion. From these it appears that tea, coffee, and cocoa retard digestion and the absorption of nitrogenised principles when peptic and pancreatic digestion are taken together, and that none of them compare advantageously with water as a standard beverage for experimental investigations. The results, of course, leave out of consideration individual variations of human digestion and the influence of the glands which prepare the gastric and other juices, but, after summarising his observations, Dr. Fraser has been able to deduce certain rules, from which we have made the following notes:—1. It is better not to eat albuminoid food-stuffs at the same time as infused beverages are taken; absorption may be more rapid, but there will be a loss of nutritive substance. 2. The digestion of starchy food is assisted by tea and coffee. 3. Bread is the natural accompaniment of tea and cocoa. 4. The digestion of meat is not much retarded by coffee, and it is suggested that perhaps this is the reason why it is usually drunk at breakfast in this country, as this meal usually consists largely of meat, or of eggs and salt meats, the digestion of which is not much retarded by coffee. 5. Eggs are the best form of animal food to be taken with infused beverages. 6. The butter used with bread undergoes digestion more slowly in presence of tea, and probably more quickly in presence of coffee or cocoa.

Liquid Carbonic Acid.—From *Industries* we learn that a company formed in Berlin for the manufacture of liquid carbonic acid, which is fast becoming an important industry in that town, is manufacturing daily over half a ton of this acid. It is sent out in steel bottles, each containing from seventeen to eighteen pounds, and the price charged is slightly under one shilling per pound. When the acid contained in one of these bottles is expanded into gas it occupies over 10,000 cubic feet. It is chiefly used for beer engines and in the manufacture of mineral waters. In the year 1879 Dr. Raydt, of Hanover, suggested that carbonic acid could be utilized for the raising of wrecks, and demonstrated the possibility of this by an experiment at Kiel. The apparatus consisted of a steel bottle containing the liquid acid and a collapsed canvas bag placed over the neck of the bottle. This apparatus is submerged and attached to the object to be raised; a cock is opened, and the liquid in the bottle allowed to expand in the bag, which becomes inflated and is thus caused to rise. Another application introduced by Herr Krupp, of Essen, is for compressing steel.

Micro-Organisms in the Air.—In the interesting paper read by Dr. Percy Frankland at the Society of Arts, on the subject of atmospheric micro-organisms, he pointed out that Koch's introduction of solid cultivating media had greatly facilitated these investigations. He had also largely used Hesse's glass tube, coated internally with sterile gelatine peptone, through which a given quantity of air can be drawn by aspiration. The estimation of the abundance of microbes in the air is made by enumerating the number of colonies obtained in a given quantity (ten litres) of air, and the following results were obtained. On the roof of the Science Schools at South Kensington, the average number of colonies varied from four in the month of January to 105 in August. On the top of Primrose Hill in May the average number was 9; at the foot of the hill it was 24; at St. Paul's Cathedral the average was 11 in the Golden Gallery and 70 in the Churchyard. The air contained much fewer microbes in country places than in towns, there being, for instance, no less than 554 in ten litres in the Exhibition Road, when crowded, on June 8th, 1886. Dr. Frankland stated that the air in a hospital ward, provided it is undisturbed, contains very few organisms, and his investigation shows the importance of preventing aerial commotion during surgical operations, and of removing dust in a moist condition.

## GENERAL NOTES.

Public Telephones.—An automatic toll-taking device for public telephones is being experimented with. The dropping of a coin of sufficient size and weight is used to complete the electric circuit.

Deep-Sea Photography.—Experiments made in France in "deep sea" photography have been successful. With a camera and the electric incandescent light it is said to be possible to photograph sunken ships, and make simpler the diver's perilous work.

Rice Cement.—A cement very much used at the present day in China and Japan is made from rice. It is only necessary to mix rice flour intimately with water and gently simmer the mixture over a clear fire, when it readily forms a delicate and durable cement.

Sea Water made Drinkable.—A new discovery is that sea water may be made drinkable by the use of citrate of silver. By this means chloride of silver is precipitated, and a harmless mineral water is produced. An ounce of citrate makes half a pint of water drinkable.

Electric Indicator for Looms.—A manufacturer of Roubaix has invented a useful application of electricity to looms. He adopts an indicator which strikes when a thread breaks, and thus saves the weaver from the close attention to the quickly-moving threads which is so injurious to the sight.

Rheumatism or Trichinæ.—An assistant of Professor Virchow, Dr. Grawitz, finds that about one-third of the cases pronounced in life muscular rheumatism, are shown by *post-mortem* examination to be due to trichinæ, or pork worms. In instances observed, it is said the parasites must have been present in the muscles for many years.

Cast Steel Tools.—A Swedish engineer, Mr. Gustafson Odelstjerna, has devised means of making hatchets, hammers, shovels, and other tools with steel of good quality, and at a low cost. The tools, are cast direct from steel, mixed with from one to four per cent. of chromium, and are said to be much stronger and better than when made of iron.

Hot Water from the Earth.—The earth's internal heat is now being used in a practical way at Pesth, where the deepest artesian well in the world is being sunk to supply hot water for public baths and other purposes. A depth of 3,120 feet has already been reached, and the well supplies daily 176,000 gallons of water, heated to 150 degrees Fahrenheit.

Electric Whistle.—An electric whistle is easily made by fitting a small brass tube with suitable apertures so that it opens against the spring of a make-and-break of the usual electric hammer type. Such whistles are cheaper to make than electric bells, and may be made to give very melodious sounds. They have recently been introduced in France, and their use seems to be meeting with favour.

Nickel and its Alloys.—According to *Invention*, Herr Fletmann, of Iserlohn, has shown that pure nickel and its alloys with copper, cobalt, and iron can have other metals added without losing the property of being welded, and therefore can still be used for making plate. The metals which can be added in this way are zinc, tin, lead, cadmium, iron, and manganese, up to as much as ten per cent.

The Congo Railway.—The Congo Company, which has the concession for constructing a railway, is sending out an expedition to select the best route, and to explore the country adjoining the Upper Congo, with a view to its commercial development. It is expected that the railway, which will join the Upper and Lower Congo, will be from 250 to 300 miles long. The expedition will be in charge of Captain Thyo, a Belgian Officer.

Curious Pebbles.—In the quaternary gravels of the Loire Valley, France, there are numerous specimens of stones, about an inch and a-half in diameter, which are remarkable for being hollow, and enclosing liquid water, and sometimes a loose stony nucleus. It is supposed that the water must have penetrated the pebbles through their minute pores, for not a sign of a crack can be seen, even by the aid of a strong glass.

Crystals of Spodumene.—The crystals of spodumene brought to view by the excavations in the Etta tin-mine in Pennington County, Dakota, are believed to be without a rival in respect to size. According to the report made on this subject by Professor Blake, it appears that one of these crystals is thirty-six feet in length in a straight line, and from one to three feet in thickness. The cleavage is smooth and straight, but the lateral and terminal planes are described as being obscure.

The Speed of Toboggans.—Mr. Bowditch, President of the Albany Toboggan Club, has had the speed of the toboggan determined. At the point of maximum rapidity, *i.e.*, just where the toboggan leaves the chute for level ground, the speed is ninety-three miles an hour. These timings have been made repeatedly by a competent engineer, and for that chute are very probably correct. The speed of the toboggan exceeds, therefore, all vehicles—even the fleet ice-boat never reaching such a terrific velocity.

Halibut in Fresh Water.—A halibut weighing thirty-four pounds and measuring forty-one inches in length was captured recently in the lower Potomac, near Colonial Beach. This is the first authentic case of a halibut in fresh water. Hitherto it was supposed that the vicinity of Long Island was the extreme southern limit of the habitat of this fish. The specimen caught in the Potomac has been preserved in alcohol by the Smithsonian Institution, and a cast has been made and placed on exhibition in the National Museum.

Morphinomania in Monkeys.—It appears from a memoir sent by Dr. Jammes to the *Academie des Sciences* that, unlike other animals, monkeys readily acquire the habit of taking morphia. When monkeys live with opium-smokers, and become accustomed to a medicated atmosphere, they acquire a taste for the poison. One monkey, for instance, would wait until its master had laid aside his pipe, and would then take it up and smoke what remained. If not allowed to do so for several days, it would fall into a state of depression and stupor, which disappeared as soon as the stimulant was supplied.

Rain Clouds.—A communication to the London Meteorological Society, by Captain Toynbee, states, as his conclusion, that clouds of not less than two thousand feet in thickness are seldom accompanied by rain, or, if they are, it is very gentle, consisting of minute drops; with a thickness of between two thousand and four thousand feet, the size of the drops is moderate; with increasing thickness of the clouds comes an increasing size of the drops, and at the same time the temperature becomes lower. When the thickness amounts to more than six thousand feet, hail is produced.

To Preserve Zinc Plates.—Plates of zinc, such as are used in lithographic and zincographic establishments, may be spoiled by a single drop of water being left on them by inadvertence. Mutton fat is an excellent means of preventing oxidation and the influence of humidity. Before using it, the plate must be rubbed perfectly dry with a smooth and clean linen rag; then the fat is lightly rubbed over the surface. When the plate is to be used again, the grease may be easily washed off with spirits of turpentine. This process is used with the best results in German and Austrian lithographic establishments.

The Number of Visible Stars.—According to the computations of M. Hermite, a French astronomer, the total number of stars visible to the naked eye of an observer of average visual power, does not exceed 6,000. The northern hemisphere contains 2,478, and the southern hemisphere contains 3,307 stars. In order to see this number of stars, the night must be moonless, the sky cloudless, and the atmosphere pure. The power of the naked eye is here stayed. By the aid of an opera glass 20,000 can be seen, and with a small telescope 150,000, while the most powerful telescopes will reveal more than 100,000,000 stars.

Artificial Whetstones.—We take the following description of a method of making artificial whetstones, from the *Guide Scientifique*. Gelatine of good quality is dissolved in its own weight of water, the operation being conducted in a dark-room. To the solution 1½ per cent. of bichromate of potash is added, which has previously been dissolved in a little water. A quantity of very fine emery, equal to nine times the weight of the gelatine, is intimately mixed with the gelatine solution. Powdered flint may be substituted for emery. The mass is moulded into any desired shape, and is then consolidated by heavy pressure. It is dried by exposure to strong sunlight for several hours.

Paper Barrels.—During the last twenty years various attempts have been made to produce a paper barrel that would answer all the purposes for which the wooden barrel is used. Recently a barrel has been produced from paper pulp, its general appearance being that of the common wooden barrel thickly varnished, while only five pieces are used in making it. It is bound with ordinary wooden hoops, and the head is of one piece, so constructed that it fits into the barrel air-tight, and is held firmly in place by a hoop without the use of nails. The body is seamless, and the interior and exterior are glazed with a substance which renders the barrel impervious to moisture, so that liquids can be transported in it without loss.

Telephone Diaphragms.—M. Mercadier, in a memoir presented to the Paris Academy of Sciences by M. Cornu, contends that the transmission of articulate speech is chiefly, if not solely, the result of molecular motion in the plate of the telephone receiver. Vibrations of the plate as a whole are only capable of yielding a single tone and its harmonics. This tone remains unaltered when the plate is supported at various points which are nodal points for this particular note, but under these circumstances the transmission of other tones is much enfeebled. Such an instrument M. Mercadier calls a mono-telephone. On the other hand, a diaphragm supported in such a manner as to be incapable of performing transversal vibration is still able to transmit speech with perfect clearness, although with considerable diminution of intensity.

Electricity for Farming Purposes.—An interesting account has lately been given before the Farmers' Club of the employment of electricity on the Hatfield estate, belonging to the Marquis of Salisbury. It appears that at Hatfield electricity is now used for working elevators to build up the hay and corn stacks, for cutting the rough grasses into chaff for ensilage, for grinding barley, maize, etc., for cattle feeding. It is also used for pumping sewage on to the higher lands, and arrangements have been made to thresh by it. The power required is obtained from a river which runs through the estate, there being a water-wheel in a central station, so that the cost of the power is merely nominal.

The Inner Structure of Cast Steel.—Some interesting experiments have been recently made on this subject by MM. Ormond and Werth, of the Creusot Works. A very thin rolled plate was placed on a pane of glass and carefully treated with nitric acid until the iron was all dissolved, in such a way as to leave the carbon in its normal condition. Upon examining the skeleton with a microscope, it was found that the carbon was very unevenly distributed throughout the mass, and that the inner structure of the steel consisted of very small particles of soft iron enclosed in cells formed by the carbon. These cells were distributed in the iron, either combined or as a collection of cells having considerable open spaces between them, so that such a plate or sheet of steel may be rolled until it becomes transparent. These spaces are irregular in shape, and even in the raw material may be almost noticeable, but they are reduced in proportion to the treatment to which the steel is subjected either by rolling or hammering, as naturally its homogeneity is then increased.

The Influence of Basic Cinder on Plants.—Some experiments made on the influence of the ferrous oxide in basic cinder on the growth of plants, was recently described by Mr. J. M. H. Munro. He says:—Seeds of various kinds —barley, white turnips, clover, white mustard, garden cress—were sown in garden soil mixed with basic cinder, for the purpose of ascertaining whether the large amount of ferrous oxide in the basic cinder in any way hindered the germination or growth of the plants. In order to test this thoroughly, very large quantities of basic cinder were used, viz., ten per cent. of the mixed soil, twenty-five per cent., fifty per cent. and pure basic cinder without any soil. Most of the seeds germinated even in the pure basic cinder, and some of the plants lived until starved for want of nitrogenous food. All the other mixtures produced plants which flowered and seeded in due course; the barley plants, in the equal mixture of basic cinder and soil, being actually better than those planted in garden soil only, and producing full ears of grain of unimpaired germinating power.

The Red Spot on Jupiter.—From our German contemporary, *Humboldt*, we extract the following:—Since the year 1878 an oval red spot on Jupiter has been attracting the attention of astronomers. It lies about thirty deg. south of the Equator, and is about 6,000 geographical miles long, and 1,300 miles in width. During the first three years it could be seen very plainly, but in 1882 it became faint, without, however, changing its shape; in 1885 it was partly covered by a whitish cloud, which threatened to veil it entirely, but which has now withdrawn, and left the spot as visible as in 1882 and 1883. It is remarkable that its rotation-time from 1879 until now, has steadily increased from 9 hours 55 minutes 35 seconds, to 9 hours 55 minutes 40 seconds, also that whilst with Jupiter generally, as with the Sun, the angular velocity increases towards the Equator, the angular velocity of the spot is less than that of the prominent points in higher and lower latitudes.

The Protection of Iron.—Hitherto the preservation of iron has been effected in very different ways. One method has consisted in converting its surface into an oxide, another in applying paint or enamel, another in coating it with zinc —a metal more readily attacked than itself. All these methods bear the aspect of being expedients merely, and do not present a definite solution of the problem. Of all the ordinary metals, lead, which resists some of the stronger acids, such as sulphuric or hydrofluoric, may be regarded as the most durable. From the *Scientific American* we learn that a new process for coating iron with an adherent layer of this metal has recently been discovered and perfected by Mr. F. J. Clamer, of Philadelphia. By it the iron is covered with a uniform coating of silvery lead, the roughnesses and indentations of the iron receiving the lead, as well as the smooth parts. The result is said to be a perfectly protected piece as long as the lead endures, and good lead is very lasting.

A Landslip in Dorsetshire.—A correspondent of *Science Gossip* gives the following account of a recent landslip near Burton, Bradstock, Dorsetshire. The strata, inferior oolite, consisting of sand intercalated with thin bands of shelly ragstone, resting upon the upper lias, having in all probability been affected by the rains and frosts of an unusually changeable winter, had slipped away from their intractable base, burying upwards of an acre of the adjacent beach beneath thousands of tons of débris. For a few hours before the sea began to play havoc with the ruins, interesting fossils were to be had in abundance. Many of these were, of course, shattered beyond all hope of reconstruction, but countless numbers of them were to be found in more or less perfect states. Among the fossils thus unexpectedly exposed were various genera of the brachiopoda, cephalopoda, conchifera, echinodermata, gasteropoda, etc., with numerous well-preserved fragments of monocotyledonous wood.

The Movement of Monuments by Heat.—We are all more or less familiar with many of the important effects produced by the expansion and contraction of metals when subjected to variations of temperature. Special provision for this is made in the fixing of railway metals, and in the construction of bridges, but it is not so generally known or thought of that the movement of towers and monuments from a vertical line is also an effect produced by heat. For instance, the Washington monument leans towards the east in the morning and towards the west in the evening. The dome of the Capitol at Washington moves in the same way, and, by means of a plumb line, it has been ascertained that in the course of a day the movement is eleven and a-half centimetres on each side of the line. A few years ago, a similar effect was noticed on the dome of St. Peter's at Rome, but we read in *Ciel et Terre* that the movement was then attributed to other causes, although it has since been recognised that the effect is due to the action of heat on the metal of the dome.

Great Pumps.—At the Engineers' Club, Philadelphia, Mr. H. R. Cornelius read a paper on the two large centrifugal pumps, recently started at the Mare Island Navy Yard, California. These pumps were designed to remove the water from a dock 529 feet long, 122 feet wide, and 36 feet deep, holding about 9,000,000 gallons. The pumps were tested by Government officials, and the following particulars are given in their report :—The performance of these immense machines was almost startling. By watching the water in the dock, it could be seen to lower bodily, and so rapidly that it could be detected by the eye without reference to any fixed point. Through the manhole in the discharge culvert the outflow from the pipes could be seen, and its volume was beyond conception ; it formed a solid prism of water, the full size of the tunnel, projecting far into the river. In 55 minutes the water in the dock fell 21 inches, and was pumped out at the rate of 112,922 gallons per minute. At one time the speed of the engines was increased to 160 revolutions per minute, and then the discharge was 137,799 gallons per minute, almost a river.

The Lick Observatory Lenses.—We learn from the *Sidereal Messenger* that these lenses were packed separately in fifteen to twenty thicknesses of soft, clean, cotton cloth ; next came a thick layer of cotton, and then a layer of paper. These packages were then put into wooden boxes lined with felt. No nails were used near the glasses, and the boxes were made the shape of the glasses. These boxes were next enclosed in two others of steel, and packed tightly with curled hair. Each steel box was enclosed in another steel box, the insides of which were covered with spiral springs. Both steel boxes were air-tight and waterproof, and the outer chests were packed with asbestos to render them fireproof. Each was then suspended by pivots in strong wooden frames, with contrivances for turning each chest one quarter round every day during the journey to California. This was to prevent any molecular disarrangement in the glasses and to avoid the danger of polarization, it being feared that the jarring of the train would disturb the present arrangement of the molecules, unless the position of the glass was changed, and all lines of disturbance thus broken up.

Halation.—When, some seven or eight years since, gelatino-bromide of silver plates rapidly made their way in the studio and field, ousting the long-established wet collodion process, it was remarked by one who had peculiar facilities for forming a judgment upon the work produced by a large number of photographers, that the change of process was marked by a great and general falling off in the quality of the negatives turned out. No doubt this observation referred more particularly to portrait negatives, but it might have been made with equal justice with regard to landscape negatives. The failing referred to is that which arises from what is known as halation, and is caused by light passing through the film, and being reflected from the back of the plate. This light, being diffused by the translucent but not transparent film, and having to travel after diffusion backwards and forwards through the thickness of the glass, is reflected on to a much larger area than that upon which it originally impinged, with the effect of fogging out all dark shadows that come in close proximity to a bright light. It is impossible to examine the landscape work shown in a photographic exhibition without being struck by the large proportion of productions which are very seriously damaged by halation.—*Photographic News*.

Deviations of the Pendulum in Mexico.—During the stay of the French Commission at Fort Loreto, in Puebla, M. Bouquet de la Grye installed, in the chapel of the fort, a seismograph, composed of a pendulum and a multiplying balance. After freeing the observations from abnormal movements, he found that the sun repelled the pendulum in the morning and evening, but that at midday its influence was attractive. The vaults of the chapel, which ran from S.W. to N.E., being heated at morning and evening, thrust the pendulum in a direction opposite to that of the sun ; in the middle of the day the influence was reversed. In grouping the observations under lunar hours, the pendulum was found to be attracted by the moon. The seismograph showed that there were frequent abnormal movements of the pendulum, there being twenty-two oscillations of the ground. The mean movements were in the direction of N.W., S.E., which is the same as that of the chain of the volcano Popocatapetil. While the oscillations were going on, the inhabitants of Puebla felt but a single earthquake shock. It would be interesting to extend these observations, by registering the movements of a long pendulum for a considerable period in an observatory ; they would furnish valuable data respecting the movement of the earth's crust and the tidal phenomena.—*Comptes Rendus*.

The Transmission of Power.—One of the most interesting problems of the present day is how to transmit power from a common centre to distant points at a cheap rate. The tidal forces on our own shores have not hitherto been utilised, yet every one who watches the rush of the tide up our rivers must realise that an enormous amount of energy is always being wasted. The transmission of hydraulic power by mains laid down in the streets is an accomplished fact in some places, but the ideal method of transmission is by means of an electric wire, or some equally convenient plan. The experiments made at Paris some months ago by M. Deprez, seemed to promise a solution of the problem, for he carried the power along wires for thirty-five miles; but the commercial efficiency of the result was not more than forty-five per cent., so that it would be cheaper to transport the potential energy in the form of coal rather than in a kinetic form over the wires. The great importance of this question brings forth some new scheme nearly every week, and the most recent, carried out near Zurich, promises well. The power to be conveyed was a water force varying from thirty to fifty horse-power, and the distance it had to be carried was some five miles. Every care appears to have been taken in making the experiment, and the results, measured both electrically and mechanically, seem to be that seventy per cent. of the power can be conveyed by means of copper wires to the desired point.

The Lighting of Manchester Exhibition.—The whole of the extensive buildings and grounds are lighted by electricity, there being over 600 arc and 3,000 glow lamps. The plan adopted by the executive was to divide the incandescent lighting into three sections: First, the Fine Art Galleries, consisting of a series of rooms, with a total of 1,620 lamps; next, the Palm House of the Botanical Gardens, used as a series of dining rooms, with 750 lamps; and lastly, the various quaint buildings, shops, and houses forming the representation of "Old Manchester and Salford," with about 600 lamps. The mains are placed underneath the flooring of the Exhibition until they reach the corner of the galleries in the east nave, where they are carried up and along the external brickwork of the galleries. Each room throughout the galleries is connected with two of the circuits, so that the lighting of each alternate principal is from a different main. In the event of any dynamo breaking down or anything happening to any one circuit, the result would be to diminish the number of lights by one half, the alternate principals in the rooms being left fully lighted. As a point of some interest, it may be noted that the length of all the main cables used for the above-mentioned sections exceeds nine miles, whilst the weight of the copper forming the conductors (cables of 19-strand wire) is calculated at very nearly 10 tons. Among the dynamos used, special interest attaches to the four Edison machines, which are of the original type, manufactured by Mr. Edison himself in New York some six years ago. They are said to have been in daily work, lighting the Theatre Royal, at Manchester, since December, 1882, and during that time not to have worn out a single pair of brushes, while no interruption has occurred to them.

Photographing by Phosphorescent Light has recently been accomplished by Professor Zenger, of Prague. Whilst watching Mont Blanc on a September evening in 1883, he was struck by the peculiar greenish-blue glow that continued to surround the summit after sunset until half-past ten. It looked as if both the snow and the limestone débris were radiating a light of the beautiful azure blue characteristic of the Lake of Geneva. The idea then suggested itself to the Professor that it might be possible to photograph with the help of these phosphorescent rays, which are known to be highly actinic. After his return to Prague, he made experiments in photographing phosphorescent objects on a plate covered with a film of Balmain's luminous paint instead of the ordinary collodion film. After exposure for a few seconds the plate was brought in contact with an ordinary dry plate in the dark, the latter plate not being particularly sensitive; and the development produced an image with all details. These encouraging preliminaries induced Mr. Zenger to try photographing the picturesque steeples and towers of Prague on a dark night. The plate was exposed for fifteen minutes and then kept in contact with the dry plate till the morning. The experiment proved a complete success; the buildings exposed during daytime to the direct rays of the sun gave off sufficient dark rays (invisible to the human eye) during the night, so that the phosphorescent plate was acted upon. After this Professor Zenger exposed sheets of music for several hours to strong sunlight, and then placed them over ordinary photographic paper. The music and prints were well copied, the notes and letters being distinct and black.

Boiler Explosions.—Among some recent lectures in mechanical engineering given at Sibley College, in America, there is one on "Steam Boiler Explosions," which is well worthy of attention. The idea is still more or less prevalent, among users of boilers, that after it has become overheated a boiler can be exploded by the sudden admission of cold water. Those who hold this opinion suppose that when the cold water comes in contact with the overheated plates, steam is produced so rapidly as to cause an immediate pressure sufficient to burst the boiler. That this is an impossibility has often been pointed out by competent authorities, and Mr. Allen does good service in again calling attention to what in all probability actually occurs. When there is too little water in the boiler and it becomes over-heated, if water is then pumped in, the plates and tubes are contorted and strained, and the joints suffer also. Then when the pressure rises the boiler is unable to resist and it bursts. The true remedy in the case of overheating is to draw the fire, and inspect the boiler when cold before subjecting it to pressure. In common with others who have investigated the subject, Mr. Allen has been struck with the fact that when cylinders or other receptacles of steam fail, they are not broken in peces nor do they burst with violence. As is well known, the effect with boilers is usually very different, and its cause is explained as follows: When a boiler cracks the pressure is relieved, and if this is effected rapidly the water being relieved of pressure is suddenly converted into steam, with a great accession of bursting power, which spends itself in breaking up the boiler and hurling the pieces to great distances.

The Purity of Mid-Atlantic Air.—In the course of an address on the action of micro-organisms on surgical wounds, Prof. F. S. Dennis, of New York, states that during his last trip across the Atlantic he made some experiments to test the purity of the air about 1,000 miles from land. He employed capsules of sterilised gelatine, and exposed them for fifteen minutes. One capsule was exposed in the state-room upon the main deck of the steamer. Within eighteen hours over 500 points of infection had developed. Two capsules exposed in a similar manner in a cabin on the promenade deck, where the circulation of air was free, showed ten days afterwards five or six points of infection each. A capsule exposed over the bow of the ship was found to be entirely uncontaminated. These experiments are on the same lines as those of Pasteur and Tyndall upon the mountair air of Switzerland, and, so far as they go, they show the germless condition of mid-oceanic air, and also the need for much more efficient ventilation in the state-rooms of even the first-class American liners.—*Lancet.*

Trichinæ in Pork.—In the Eulenberg quarterly journal of Forensic Medicine official returns are given of the examination of pigs for trichinæ and measles in Prussia during the year 1885. According to this no less than 4,421,208 pigs were examined, and of these 2,387 were found "trichinous," so that for every 1,852 pigs there was one trichinous. The number of communities in which trichinous pigs were found amounted to 849, and 13,653 pigs were suffering from measles. It is also stated that 101 American sides of bacon and bacon preparations were found to contain trichinæ. These investigations were made by 21,117 official meat inspectors.

## DOMESTIC SANITATION.

No. 2.—Ventilation.

PURE air is, if anything, even more essential to our well-being than pure water. We may dispense with water, or, indeed, with drink of any kind for hours in succession, but very few of us could survive the total deprivation of air for even five minutes. It is fortunate, therefore, that no enterprising company can monopolise the air-supply of any district, and dole it out to the consumer in such quantities and of such a quality as they may think proper.

But, on the other hand, we cannot improve our air-supply as we do our allowance of water. We may dip up from a stream or a well a pailful of water, and by Clarkising, by judicious filtration, or by the addition of a pinch of alum—as the Chinese have done from time immemorial with their foul river-waters—we may render it capable of being used with safety. But with air we have no such resources. We cannot have in our dwellings an atmosphere purer than that outside, and unless we are careful it may become very much worse.

To prevent it from being thus deteriorated is the one aim of domestic ventilation.

To this end we have to allow the plentiful entrance of fresh supplies of air from without; to prevent the entrance, as far as possible, of "ground air" and of sewage gases; and to arrange for the quick escape of such air as may have become vitiated by the respiration of the inmates, by the emanations given off from their skins, or by the products of the combustion of gas, lamps, etc., and the smoke which escapes from our chimneys.

The quantity of air which should be supplied to a room has been very variously estimated. Dr. Neill Arnot and Sir H. Roscoe take twenty cubic feet per minute for each occupant. But it is plain that the loftier a room, and the larger with relation to the number of persons present, the more slowly will a change of air be required. In good dwelling-houses five cubic feet per minute for each inmate will generally prove sufficient. But in schools, barracks, theatres, churches, and, above all, in hospitals, twenty feet will certainly not be excessive.

A large allowance must be further made for artificial lights, especially for gas. One gas-burner whilst in action will spoil as much air as do three men. The electric glow light has here the advantage over all other sources of artificial light, that it does not vitiate the atmosphere at all.

The next question is, where should the supply of air be admitted? The answer is, in the first place, not near the surface of the ground, as there it is most likely to be polluted with dust, the emanations of the soil, etc. Nor should it enter dwelling-rooms through passages, cellars, outhouses, and, above all, through water-closets, but as far as possible directly from the open outside. Windows are generally better inlets than doors.

As regards the manner of introducing the air-supply, there are two main systems. In the one, fresh air, drawn from suitable points, and warmed to some convenient temperature, is forced into a house, and drives the impure air out at any and every opening. This system is the best where practicable. Unfortunately, it is rarely available in private houses, as a source of motive power is needed to work the forcing pump.

In the other system the vitiated air is drawn out through the chimneys, through special shafts, at the windows and doors, whilst fresh air rushes in at every opening and crevice to take its place.

This system requires no special machinery; a Neill Arnott's valve-plate opening into the chimney just below the ceiling will let the foul air escape whenever there is a fire in the stove. Or should a downward draught occasionally get the upper hand in the chimney, the valve closes automatically, and prevents the smoke and combustion gases from entering the room.

In fine weather almost all the necessary ventilation may be effected by simply opening the windows, preferably both at top and bottom. But in frost, fog, driving rain, and northerly or easterly winds, this expedient is not admissible. Hence a pane of glass may be provided near the top of a window, drilled with a number of fine holes. Or instead of the pane, there may be let into the window a frame fitted with louvre-plates of glass.

One channel through which the outside and the inside air are constantly interchanging is not generally known. It takes place through the walls themselves, through brick, free-stone, plaster, and through ordinary paper-hangings. That such an interchange of air does take place may be proved by a very simple experiment. We take an ordinary brick and coat it completely over with a good varnish, leaving uncovered merely two circular spots about the size of a shilling, and exactly opposite each other. If when the varnish is dry we apply the lips to one of these bare spots and blow strongly, the blast may be distinctly felt coming out at the other. By slightly modifying the experiment, it is even possible to blow out a candle through the brick.

If we consider what a relatively large surface the walls of a house present, and that this interchange of air is taking place day and night through every square inch of this surface, we shall see that we have here a very important agent in the supply of fresh air. All this holds good, however, only so long as the ordinary building materials are used. If the walls of a house are coated inside or out with oil-paint, or lined with varnished paper-hangings, this channel of ventilation is cut off, and the entire task is thrown upon the windows, doors, and chimneys.

Some kinds of stone are also air-tight. White marble palaces are doubtless charming to read of in poems and novels, but they do not allow of the free interchange of air, and are consequently damp and stuffy, except in climates which admit of large windows standing open at all seasons of the year.

On this same peculiarity a very plausible suggestion for utilising the slag from blast-furnaces has been shipwrecked. It was proposed to cast the slags in the form of large blocks, and to use them in building houses. They have, in fact, been used with success in erecting sheds, walls, etc., in manufacturing establishments. But when they were tried for the outer walls of houses, it was found that the plaster did not dry within any reasonable time.

We must now take a glance at the evil airs and gases which should by all means be excluded from our houses. Foremost amongst these ranks sewer gas. This term serves to include all gases and vapours given off from putrefying excrements, and, generally speaking, from organic matters. The nature of these gases, and the manner in which they may serve as vehicles of disease, we shall endeavour to explain on some future occasion. For the present we must consider the manner in which they find entrance into our houses. Foremost come water-closets insufficiently trapped; then follow wash-basins in bedrooms and dressing-rooms, connected with the sewer, and capable of being emptied by merely drawing a plug. When this is done, down rushes the water, and up comes in its stead a volume of sewer-gas.

Untrapped or insufficiently trapped sinks act in precisely the same manner. The leaden soil-pipes from water-closets often allow of the escape of sewer-gas, since the metal in course of time becomes corroded and presents a number of chinks and perforations. Worst of all is the branch-sewer carried right under the flooring-boards of dwelling-rooms. Such sewers consist of earthen pipes, not cemented together, but merely puddled with clay, which gradually crumbles away and allows of the escape not merely of gases, but of liquids also, which by degrees form a putrid pool underneath the house.

It is important to put on record that some little time ago the medical officers of health of all the metropolitan districts unanimously recommended that no such branch-sewer should be in future carried underneath the floor of any house, unless duly cemented and embedded in concrete.

Ground-air is a possible source of disease, which was completely overlooked until its existence was pointed out by Professor von Pettenkofer. Every one must see that the pores of the ground, unless waterlogged—which is not a desirable state of things—must be filled with air, and air, generally speaking, of a bad quality. Organic matter of different kinds is washed down into the earth by rain, and there passes gradually into decomposition. The soakage from cesspools, graveyards, etc., yields a plentiful supply of putrescent matter for the pollution of the ground-air. The case is perhaps worst in houses built upon what is called "made-ground," where hollows and excavations have been filled up with any and every kind of refuse which was at hand.

But it may be asked, why should this ground-air discharge itself into our houses, rather than in the roads and the courtyards? The reason is twofold—on the one hand the air of a house is generally warmer than that outside, and being thus expanded rises upwards, just as in a chimney. In so doing it draws the ground-air upwards. Another point is that the surface of the ground in the streets and courts is made, comparatively speaking, air-tight by flagging, paving, or asphalting. Hence the surface under a house is the region of *least resistance*, and there, accordingly, the gases from below find vent.

It would be a great improvement if the ground upon which a house stands were well coated with concrete or asphalte so as to cut off this ascending current.

Dr. W. B. Richardson, when describing his imaginary model city, Hygeia, proposes that the houses should be built upon a series of arches, so that a current of free air might always be able to play between their foundations and the ground. This, from a sanitary point of view, would be a most excellent arrangement, but, like some other of the learned doctor's suggestions, it is impracticable on economic grounds. Houses so constructed would be too costly for all except the rich. Hence we must limit our aspirations to the asphalting of the ground underneath our dwellings and the banishment of sewers placed under their floors.

But even when sewer gases and ground-air are completely excluded from a house its atmosphere is constantly becoming vitiated, and requires, therefore, continual renovation. One of the chief causes of this deterioration is, as is pretty generally known, the decrease of oxygen and the increase of carbonic acid, due to the respiration of the inmates. In crowded rooms not duly provided with facilities for ventilation the oxygen may fall from its normal standard of 20.8 parts per cent. by volume down to 20, or even lower, whilst the carbonic acid gas may rise from 0.04 per cent. to more than double that quantity. In such proportions it occasions languor, headaches, and, if habitually breathed, it brings on a state of general debility, which predisposes the sufferer to the attacks of any disease.

Yet, paradoxical as it may sound, this excess of carbonic acid is not the most objectionable ingredient in the air of an ill-ventilated room. In fact, the most able sanitarians view it chiefly as an index of *animal pollution*. Wherever it is found in abnormal quantities, and where there is no source for its production save the respiration of human beings, there will also be found an excessive quantity of animal matter, either as a vapour or in minute solid particles. This animal matter quickly putrefies, and to it is due that peculiar smell found in ill-aired and over-crowded rooms, and known familiarly as "stuffiness." This smell adheres to the clothing, to the hair, and generally to the persons of the inmates, and is at once recognised by medical men as proof that a patient, *e.g.*, in the hospital, has been living in bad air.

We have been supposing that the inmates of a crowded dwelling are all in a normal state of health; but if any of them are sick, even of some disease not recognised as infectious, the case is much worse, and the need for ventilation is far greater. The animal matter thrown off from the skin and the lungs of a diseased person is greater in quantity and different in quality from that which emanates from a healthy man.

In most cases, indeed wherever practicable, no person suffering from any disease should remain in a room in which other persons have to sleep or eat.

We have, in passing, mentioned the products of combustion as taking no small share in polluting the air of our houses. Lamps, candles, gas-burners, stoves, consume oxygen and throw off carbonic acid just as do living animals. Indeed, it is no easy matter to draw a sharp distinction between life and combustion.

However, carbonic acid is not the only undesirable product of combustion. Wherever the supply of oxygen is not fully proportionate to the carbon, carbonic oxide, or, as it is now called, carbon monoxide, is generated. This gas is far more harmful than carbonic acid. It is fatal even if mixed with common air, or with oxygen in very small proportions. In a method of suicide much in vogue in France, where a person weary of life shuts himself up in a small room with a chafing-dish of burning charcoal, carbon monoxide is in fact the chief deadly agent.

Another objectionable product of the combustion of coal and coal-gas is sulphurous acid. All coals and all coal-like bodies, except, perhaps, far-famed Tortane Hill mineral, now no longer to be procured, contains sulphur. This sulphur, on burning, is converted into sulphurous acid, which in the case of gas flames escapes into the room. Every one knows that sulphurous acid, if in sufficient quantity, occasions death by suffocation, and, *e.g.*, in the underground railways it is very annoying to persons whose lungs are sensitive. But in houses it seldom reaches a proportion at all dangerous to health, though it is very destructive to books, pictures, textile goods, and articles of polished metal.

Both carbonic oxide and sulphurous acid find their way into a room most readily if coal or coke is burnt in a cast-iron stove not placed under a chimney. Iron at high temperatures allows these gases to pass through its pores. Closed stoves built of Dutch tiles, stoneware, etc., are, however, perfectly safe.

Perhaps the most effectual means of securing bad air in a room is to heat it with a chimneyless gas-stove. We have seen devices of this kind where, in the hope of arresting the carbonic acid, a dish of cream of lime was placed at some height above the burners. But lime is quite unable to absorb carbonic oxide, so that the more dangerous gas passed freely into the room.

Perhaps we may best wind up this sketch of the ventilation question by suggesting a very simple method for judging of the quality of the air in a room. If you step out for a moment into the open air and on returning find a "stuffy" smell you may know that the ventilation is insufficient.

In bedrooms—if of such a size and shape that the current of air does not blow directly over the person of the sleeper —the windows should be left open all night, save in time of fog, frost, etc. The notion that night air is essentially unwholesome holds good only in districts where malaria reigns.

*(To be continued.)*

## THE CONDUCTIVITY OF METALS.

WE are all more or less familiar with the fact that different substances vary greatly in their powers of conducting heat. Organic substances such as wood, cotton, wool, etc., are bad conductors, and it is chiefly for this reason that nature has clothed birds and animals with feathers and fur, as they help to keep up the necessary temperature of the body. Metals on the other hand are good conductors of heat, as we know by varied experience; if we wish to lift a hot smoothing iron we take good care to cover the handle first with a piece of flannel or other bad conductor, and for the same reason the handles of metal tea-pots are made of wood or ivory. Many other instances could be given, but it

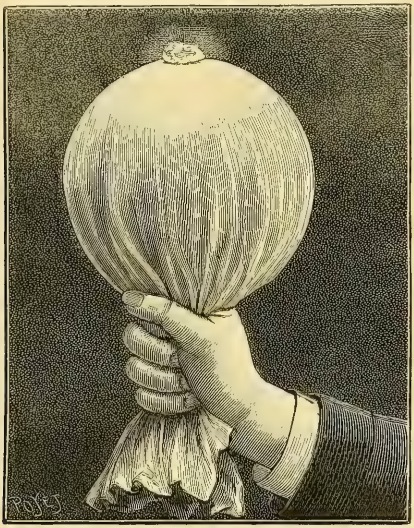


Fig. 1.—Muslin over metal ball not burnt by red-hot cinder on top.

is needless, as they will readily occur to any one whose attention is directed to the point. Recently *La Nature* has given two rather striking examples, which are shown in the accompanying illustrations. If a ball of copper or other metal some three or four inches in diameter be covered tightly with thin muslin or cambric, as shown in Fig. 1, a red-hot cinder from the fire can be placed on the top of the ball, and it can be made to glow by breathing on it, without the muslin or cambric cover being injured. This is simply due to the fact that the metal ball conducts heat away so rapidly from the part next to the hot cinder that the cotton covering, although very inflammable, never becomes hot enough to burn. In Fig. 2 we have shown a piece of muslin or cambric stretched tightly over the end of a gas burner: if the burner is metal, and if the cotton covering is without creases at the top, the gas can be turned on and lighted without the covering being burnt. In this case also the explanation is a very simple one: the metal burner conducts away the heat of the flame so rapidly that the cotton covering never reaches a temperature high enough to injure it.

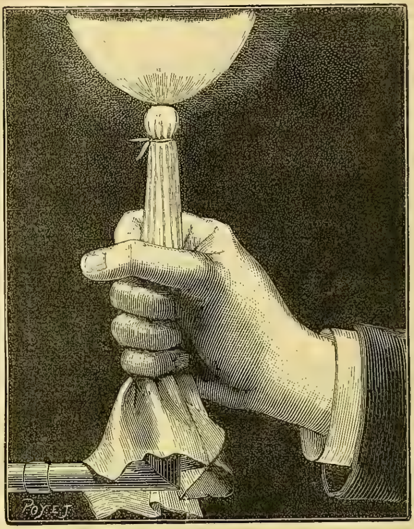


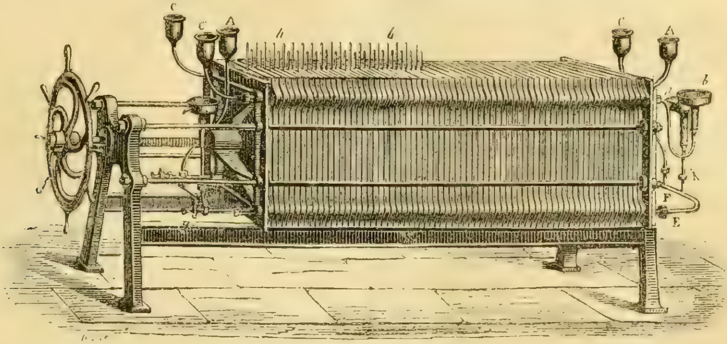
Fig. 2.—Muslin over end of gas-burner not injured by flame.

## OSMOSE.

IT has been known for some time that when two liquids are separated by a thin porous partition, such as a sheet of animal membrane, unglazed earthenware, or porous stone, the liquids gradually pass from one side to the other of the partition. If, for instance, a solution of common salt be on the one side of the division, and water only on the other, the salt will pass in one direction and the water in the other. Or if a membranous bag is filled with a strong syrup, or some other fluid denser than water, such as milk or albumen, and if the bag thus filled is placed in a vessel containing water, the following change will take place:—Water will gradually find its way into the bag, and by degrees the water on the outside of the bag will contain some of the syrup or other fluid put into the bag. If, on the other hand, the bag is filled with water, and immersed in a syrup or other fluid denser than water, gradually water will leave the bag, and syrup will pass into it. The passage of liquids to the two opposite sides of the partition will not take place at the same rate, and the flow of the liquid towards that which increases in volume is sometimes called *endosmose*, and the flow in the opposite direction *exosmose*, but for general purposes it is sufficient to adopt the single word *osmose* (from ὠσμός, impulsion) to denote the interchange of the fluids. Osmose plays a most important part in organic life, the cell-walls being the diaphragms through which the necessary interchange of fluids and dissolved substances takes place, as in the passage of the products of digestion from the digestive cavities into the vessels containing the circulating materials.

Many manufacturing processes depend on these phenomena, but for the moment we will merely describe a useful apparatus called an Osmogene, made by Messrs. Lecointe and Villette, of St. Quentin, France. It has been known that molasses, which is obtained as a bye-product in the manufacture of sugar, contains a certain amount of sugar which cannot be recovered by the ordinary way, as the salts in the molasses prevent the crystallisation of the sugar. The difficulty, however, can be overcome by osmose, and if on one side of a parchment membrane there is hot molasses and on the other side hot water the required action will take place. Some of the water will pass through the membrane to mix with the molasses, while some of the soluble salts in the molasses will pass in the opposite direction to mix with the water. The result is that the water becomes more or less charged with salts, and the molasses are proportionately freed from them. From this it follows that a portion of the sugar which at first could not be crystallised can now be recovered, the salts which prevented this crystallisation being no longer in the molasses, or, at all events, being present in such small quantities that they do not prevent the sugar from crystallising.

The apparatus referred to is shown in the accompanying illustration, and from this it will be seen that there are several vertical frames squeezed together by a screwed shaft and wheel. The frames are made of wood, and on each one there is stretched a parchment diaphragm. The hot molasses is poured in through the funnels A A, and the hot water through C and C. In each of the four angles of each frame there is a hole, one at the bottom for the admission of molasses and one at the top for the outlet of molasses osmosed; also one at the opposite corner at the bottom for the admission of water and at the top for the outlet of water osmosed. The tube C with a funnel at the end is to allow air to escape from the molasses outlet. The funnel B is for testing the osmosed water. By treating the molasses in several frames successively a large proportion of the soluble salts is removed, and the sugar remaining can then be crystallised.




MACHINE FOR OSMOSING MOLASSES.

## TRUE AND FALSE DEW.

As stated in our last number, Mr. John Aitken, F.R.S.E., attacked the established theory of dew in two essential points, viz., as to its formation, and as to its nature. It was convincingly shown that the theory of Wells, according to which the dew falls from the air above, is untenable; and that, on the contrary, it rises from the ground below. We now consider his conclusions upon the nature of dew.

It was proved by the late M. Boussingault that plants transpire an immense amount of invisible moisture from their leaves, and that this moisture is supplied from the roots. Now, if the root pressure is great, and the evaporation is checked, the sap is forced into the plant, and escapes in a visible form by the outlets supplied by nature. Dr. Mool, of Amsterdam, six years ago, in special experiments on the subject, placed the leaves of plants under the most favourable conditions for the excretion of drops, and substituted for root pressure, a pressure produced by a column of mercury. Out of sixty plants of different kinds and ages, the leaves of twenty-nine excreted drops without being injected, thirteen leaves became injected and excreted drops, and eighteen became injected and did not excrete at all.

Mr. Aitken continued the experiments. He removed a branch of the poppy, which had shown a strong tendency to exude moisture, and connected it by means of an india-rubber tube, with a head of water of about forty inches. After placing a glass receiver over it, so as to check evaporation, it was left for three hours, when it was found with drops of water at different parts of the edges of the leaves. He noticed in the leaves of broccoli that the moisture collected on them was not deposited according to the laws of radiation or condensation; but that it appeared in little drops placed at short distances apart, along the very edge of the leaf, whilst the rest of the leaf was dry. The moisture was not equally distributed, but appeared in large isolated drops. On further examination, by placing a strong light below the blade, he observed that the position of the beautiful sparkling diamond-like drops which studded its edge had a definite relation to the structure of the leaf; they were all placed at the points where the nearly colourless and semi-transparent veins of the leaf came to the outer edge. He fitted a full-grown leaf into the apparatus and applied the water pressure. In an hour it exuded water, and soon got studded with drops along its edge in exactly the same way as was observed on it in the garden on a summer morning. A young leaf was subjected to the same test, but it did not excrete at all.

On colouring with aniline blue the water which was to be injected into the leaf, it was seen that, after the pressure was applied, the drops which first appeared were colourless; but in a short time the blue tint appeared. This showed that there was at first very little water in the veins. Soon the whole leaf got richly coloured with a healthy blue-green hue, the injected fluid having penetrated through it all.

He next selected a turf of grass, and placed over it a glass receiver, till drops were excreted. Removing the receiver, he selected a blade with a drop attached to it. Over this he placed a small dry glass receiver, so as to isolate the tip from the damp air of the large receiver. Its open end was closed by a thin plate of metal; through a small slit in this plate the tip of the blade was entered; and to prevent moisture entering and coming in contact with this tip, an air-tight joint was made between the blade and the metal with india-rubber solution. The large receiver was then placed over the turf to prevent evaporation from the lower part of the blade. After some hours, a drop was found on the tip of the blade inside the small receiver, of the same size as the drops on the turf blades outside the small receiver. This showed that these drops were really exuded by the plant, and not extracted from the air. When the roots were cut, no drops were found. But when to the rootless stems the india-rubber tube, with water pressure, was applied, drops were immediately seen at the tips of the blades.

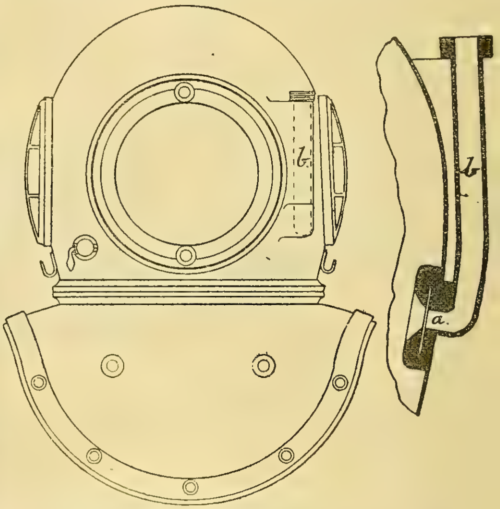
Careful observation showed him that the formation of drops on plants that exude moisture depends on the rate of supply, the humidity of the air, and the velocity of the wind. The drops that first make their appearance on grass are not drops of dew at all, and their appearance depends not on the laws of dew, but on those of vegetation. Hence the varied distribution of moisture on plants and shrubs on dewy nights. Much of the moisture that collects on plants at night does not form like dew on dead matter. Dead matter gets equally wet where equally exposed, and the moisture does not collect on it in isolated drops, as it does on plants. The drops which appear on grass on clear nights are not dew at all, and they make their appearance on surfaces that are not cooled to the dew-point. That is *false* dew. But after these drops have been forming for some time, *true* dew makes its appearance when the radiation increases, and the plants get wet all over as in the case of dead matter.

True dew is formed on fewer nights than we might at first imagine. On many nights on which grass gets wet, no true dew is deposited on it; and on all nights, when vegetation is active, the exuded drops always make their appearance before the true dew. When, therefore, we walk over the lawn in early evening, the wet which we may brush off with our feet is not dew, but the juices exuded through the veins of the grass blades. Careful observation will show the difference between the exuded juice-drops and the true dew; the moisture exuded by grass in a drop of some size is always excreted at a point situated near the tip of the blade and at the extremity of a vein, often when the rest of the blade is dry, whereas true dew collects evenly in a pearly film over all the blades. The false dew appears in large glistening drops; the true dew coats the blade with a fine filmy lustre.

This accounts for the strange phenomena often observed in garden plants. Certain kinds are found covered with moisture, while others are dry. Many plants of the *Brassica* family are heavily covered with diamond-like drops; while peas, beans, etc., growing beside them, are quite dry. Again, in clusters of plants of the same kind, some are found wet and others dry; besides, some branches are wet while others are not so. According to the ages of the plants, and their exuding powers, these phenomena present themselves. On dead leaves no drops are found, although there may be a thin pearly sprinkling of moisture all over. The large drops, which we are accustomed, both in poetry and science, to consider as dew, are not dew at all, but watery juices from healthy plants; whereas the true dew —not so often seen—is the fine film which is found on all substances on a favourable night.

## SPEAKING APPARATUS FOR DIVERS.

THE accompanying illustrations refer to a very simple apparatus, which enables divers to hold *vivâ voce* communication with their attendants, and it is equally applicable to diving-bells or to helmets. The figure shows a diver's helmet with the speaking apparatus (*b*) attached, also a section of the latter which may be explained in few words. A small hole is made in one side of the helmet, and over this is fixed a thin metallic diaphragm (*a*), suitably protected on the outside. This constitutes the whole of the apparatus, and on being connected with a flexible tube, leading to the attendants above water, it can at once be used. Any one who has had occasion to put on a diver's helmet must have noticed that the noise is almost unbearable if the person with the helmet on speaks to himself, even in a low voice. Incidentally, too, it may be mentioned that a helmet conducts sound so well




DIVER'S HELMET, WITH ENLARGED SECTION OF SPEAKING APPARATUS.

that when two divers literally "put their heads together" when under water, they can converse freely. Formerly divers had to depend for communication with those above water on signals conveyed by a line, and serious mistakes sometimes occurred; moreover, by this system the diver could not report what he was doing, or say anything as to the condition of his work. He either had to rise to the surface, or write more or less illegibly on a slate. More recently telephones have been used, but they are not so simple as the apparatus now under notice, and with the latter no battery is required. It might, perhaps, be suggested that a mere speaking-tube without a diaphragm would do, but there are two insuperable objections to this. In the first place, if by mischance the tube became injured, water would rush into the helmet with the most disastrous consequences. Even if this did not occur, there would remain the fact, that without a diaphragm the air pumped into the helmet for breathing purposes would escape through the speaking-tube, and it would then be impossible to use the tube for speaking purposes. When the new system is applied to a diving-bell, as shown in our illustration, the diaphragm is fixed in the roof, and there is a short tube with a mouthpiece in the bell. The apparatus described was devised by Mr. W. A. Gorman, and is made by Mr. A. E. W. Gwyn, of 9, Ducks-foot Lane, London.

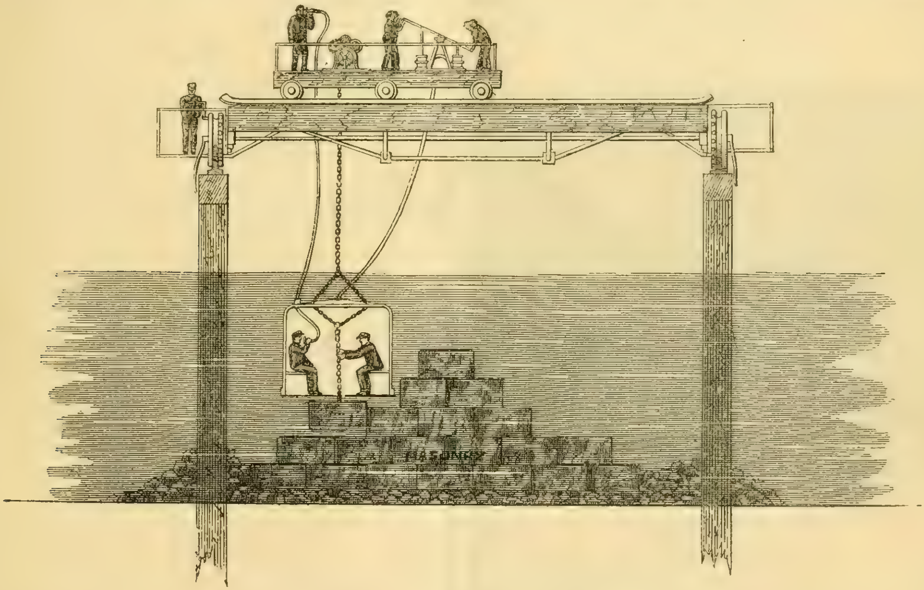
## THE DECAY OF LEATHER-BOUND BOOKS.

SOME years ago Dr. Angus Smith* observed that the leather in his bookcases became rotten in exact proportion to the height above the ground. At the top of the room the leather became so friable that it could scarcely be handled; near the ground it was still pretty firm; the intermediate levels were affected according to their height. Gas was commonly burned in the room, and Dr. Smith attributed the decay of the leather to sulphuric acid, formed as a product of the combustion of impure coal-gas. The experience of many other sufferers tends to confirm Dr. Angus Smith's explanation, but it may be questioned whether sulphuric acid is the sole destroyer of the leather in books and bookcases.

To begin with, some books are much more rapidly affected than others. Ordinary glossy calf, law calf, and russia perish first. Good morocco, lettered in gold (not Dutch metal), will resist indefinitely; and here and there a calf-bound volume is found to be uninjured, while its neighbours right and left have fallen to pieces. This exemption of particular books suggests a destroying agent more selective than mineral acids. Moreover, it has been observed that the crumbly leather from the hinges of a decayed bound book exhibits, when examined under the microscope, fine filaments, the thread or mycelium of a mould. The books which perish most rapidly and certainly are those which have been coated over with a paste wash, in order to get a glossy surface by burnishing, and it is probable that this starchy mess furnishes a medium well fitted for the spread of a mould. Heat and foul air favour such growths, and mould, as well as sulphuric acid, forms rapidly in the upper air of a hot room. Bad leather, without antiseptic treatment, aided by a glaze due to starchy paste, will account for the decay of leather binding, whether gas is burnt or not; but it must be admitted that the products of combustion of impure gas hasten the process in a startling degree.

A remedy for this evil exists. Books may be bound without extravagant cost, in a way which effectually checks the ravages both of gas and mould. Use no calf or russia under any circumstances. Bind valuable books, or such as are to endure much wear, in half-morocco and the rest in cloth. See that the sheets are sewn, not upon strings, but upon broad tapes. Make each side of the cover of two good millboards glued together, and pass the tapes between the boards. To make sure that this is done right, and that the millboard is of good quality examine the book for yourself before the end-papers are fastened down. Books thus bound need not cost more than the perishable half-calf now in ordinary use, and this is said upon the authority of a specification and estimate which have regulated the binding of several hundred books. Honest leather or sound cloth will not soon perish, even in a foul and heated atmosphere.

* "Air and Rain," p. 528.



DIVING BELL WITH SPEAKING APPARATUS.

## THE SPECTRUM.—I.

SIR ISAAC NEWTON, writing to Oldenburg, on January 18th, 1671, proposes to communicate to the Royal Society "an account of a philosophical discovery, being in my judgement the oddest, if not the most considerable detection which hath hitherto been made in the operations of Nature." This discovery was communicated on February 6th, and excited great interest among the members, and "the solemn thanks" of the meeting were ordered to be transmitted to its author for his "very ingenious discourse."

The refraction of light by glass and crystal had been investigated by Ptolemy in the second century. Lord Bacon described no new discovery when he wrote in his Sylva Sylvarum or Natural History, "*Precious stones* have in them fine *spirits* as appeareth by their *splendor. Prismes* are also comfortable things"; or in his Novum Organum, "If the nature of colour is inquired into, the solitary instances are gems of christal, which yield not not only a colour in themselves, but cast it upon a wall."* But it was generally supposed that light of every colour was equally refracted or bent in its path by a lens or prism.

Newton "let in a convenient quantity of the sun's light" through a hole in the shutter of a darkened room. "It was at first a very pleasing divertissement to view the very vivid colours produced thereby." But he was not so much struck by the colours, nor did he stop to speculate how "they may work by *consent* upon the *Spirits of Men*, to comfort and exhilarate them," as did Lord Bacon, but was interested in noticing the length of the band of coloured

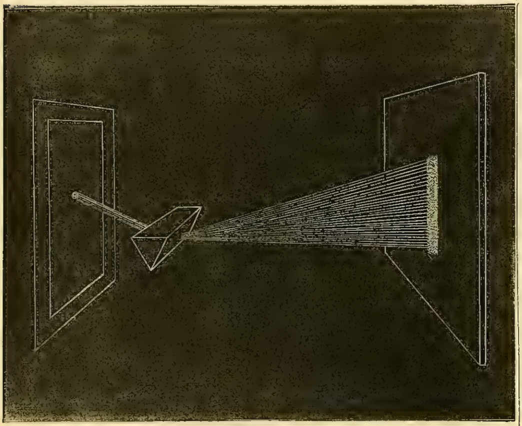


Fig. 1.

light upon the wall compared with its breadth. The hole was round, but the band was five times longer than its breadth.

"He thought it not amiss to examine.... what would happen by transmitting light through parts of the glass of divers thicknesses, or through holes in the window of divers bignesses.... but he found none of these circumstances material. The fashion of the colours was in all cases the same." After making various experiments he imagined the rays might take curved paths, for "he had often seen a tennis ball struck with an oblique racket describe such a curve line"; but "this plausible ground for suspicion" was destroyed by further observation.

At length he let the coloured band, or spectrum, from the prism fall on a board with a hole in it, and thus allowing one colour to be dealt with at a time, he passed this colour through a second prism, and allowed the light to fall on another screen. The ray examined in this manner apart from the rest, underwent no further change beyond a slight elongation.

Turning the first prism so that one colour after another passed through the hole and fell on the second prism, he noticed that the rays were bent at different angles. He was then led to make his great discovery, which may be stated thus; *white light consists of rays differing in colour and refrangibility.* He described the colours as seven in number—violet, indigo, blue, green, yellow, orange, and red. But it was explained in our Notes on Colour* that indigo should

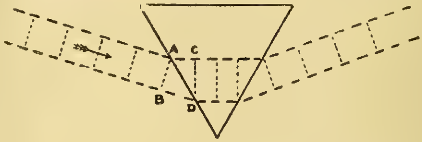



Fig. 2.

not rank as one of these. The red is the least bent and the violet is bent the most.

Before proceeding to discuss the spectrum more minutely, it will be well to describe by an analogy how the light is acted on by the prism.

When a beam of light passes from air into water or glass, meeting the surface at an angle, it becomes bent. This happens because light travels more slowly in the denser substance. A similar deviation would take place in the direction of march of a column of soldiers moving blindly or in the dark, if they came upon a field of heavy soil or rough ground.

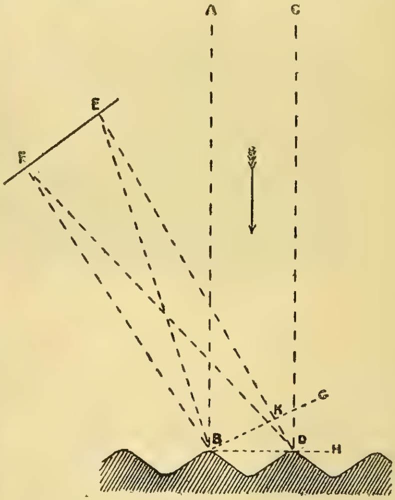



Fig. 3.

The man at A on the left-hand side of the column would be the first to meet with the retardation, and while he marched from A to C the corresponding men at B would have marched to D. The effect would be to swing the front of the column round, and so change its direction. If the further boundary of the heavy ground were parallel to that at which it was encountered, the column would resume its original direction of march, but if not, another deviation would take place, as in fig. 2. A ray of one colour only

* "Translated and taken out of the Latine by M.D. B.D. 1677." The second *not* is apparently a misprint.

* Vide ante p. 12.

is represented in this diagram; there is therefore no dispersion or splitting up into different coloured rays.

We may stretch the analogy further by supposing that some of the men are smaller, and take shorter and quicker steps than others, and we may imagine the retardation to be due to deep heather or stones. If these obstacles are not extremely small compared with the size of the men, it is clear that the smaller men will suffer most, and will be most retarded, and, supposing them all to be marching blindly, they will deviate most from the original direction.

Bearing in mind that it is the wave front of the ether vibration which we compare to the ranks of men, not the vibrations to the individual men, this is analogous to what occurs with light.

Cauchy has shown that the separation of the different coloured rays of light—or dispersion—may be accounted for if we assume that the wave length of the vibration of light is not enormously greater than the size of the molecules or ultimate particles of matter.

Taking a wave length at about one-50,000th of an inch, it is probably not more than 10,000 times greater than a molecule, which would be therefore one-500,000,000th of an inch, and this agrees fairly with estimates arrived at from several totally independent sources.

It is conceivable that the smallest men would be retarded in greater proportion than that of their height compared with men of medium stature; and we find a corresponding effect in the great deviation of the violet end of the spectrum when produced by a prism, compared with other methods which will be described hereafter.

By deviation is meant the refraction of a ray of any one colour. By dispersion is meant the difference of the refrangibility, or capability of being refracted, of different coloured rays. The larger or blunter the angle of the prism up to a certain point, the greater is the deviation, and correspondingly greater is the dispersion. But different kinds of glass have different powers of refraction and of dispersion. Heavy glass has a greater effect on the path of a ray of light than light glass. Flint glass has greater dispersive power than crown glass. The dispersion of various qualities of glass differs not only in degree, but in the manner in which one colour is refracted compared with another.

There is another means of producing a spectrum which, though at present not so common, has many important advantages; the foremost of which are that the position of each colour corresponds exactly to its wave length, and that a scale of wave lengths can be easily applied to the spectrum. There is no extension or spreading out of the violet, and the colours are invariably in the same position with regard to each other.

This method is that of *diffraction*, and to this we owe the colours of mother-of-pearl, and most of the hues of the peacock's feather.

Instead of passing a beam of light through a prism, it is allowed to fall on a flat or curved piece of polished metal, on which a number of equidistant parallel lines are engraved. From 4,000 to 8,000 lines to the inch are required to produce a good effect, but as many as 112,000 lines to the inch have been ruled for this purpose. Such a plate is called a grating.

In fig. 3. a section of such a grating is represented very roughly at B D. A ray of light of a certain colour from A, falling on the grating at B, is reflected in all directions in the plane of the paper; only two of these directions will be considered at present, B E and B F.

For the particular colour there is a certain wave length, as has already been described in these columns. There will be a certain number of wave lengths in the length E B. Let another ray of the same colour from C fall on the grating at D, and be reflected in all directions. Let D E and D F be two of these. The wave lengths are roughly represented by the breaks in the lines, and with more distinctness than by drawing the diagram with sinuous or wavy lines. A short line and the following white space may be taken to represent one wave length. It will be found that at E, the waves coming from B and D coincide, but at F they have, as it were, got out of step by half a wave length. The result will be light at E, and darkness at F. It is clear that the vibrations help each other at E, because the lengths E B and E D contain an exact number of wave lengths, differing in this case by one between K and D; but if the ray of light were of another colour the vibrations would *not* coincide at E, but would be more or less out of step; there would be therefore little or no light.

The position E therefore represents the full effect of light of one colour, and in the same way, at other positions on the line E F, the full effect of lights of other colours will be found, and, in short, a spectrum will be displayed. In practice the spectrum is not thrown on a screen at E F, but is observed through a telescope; the same means are used for observing a refraction spectrum.

If the angle E B A is measured, and the distance B D is known, the length K D can be calculated from the angle G B H. By this method it is easy to measure the wave length of a ray of light of any particular colour.

*(To be continued.)*

## A TRAVELLING PLATFORM.

To lessen the fatigue of visitors to the International Exhibition to be held in Paris in 1889, M. Eugène Henard has suggested the use of an endless train or moving platform, as shown in the accompanying illustration, Fig. 1. His idea is to have the platform on the ground level, and to let it travel slowly, so that any one can

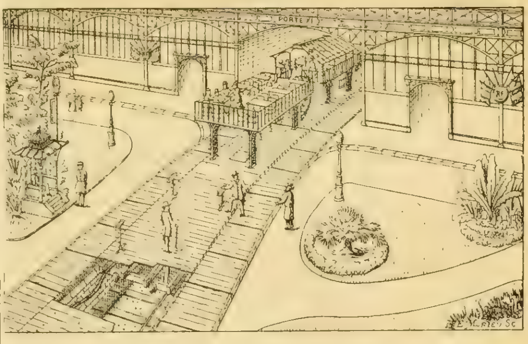



Fig. 1.—Endless Moving Platform.

step on or off without the train being stopped. He also proposes to let visitors use the train gratuitously, and to cover the working expenses by having seats and elevated *cafés*, for the use of which a charge will be made. He believes that many persons will use these, as they can then make a complete tour of the exhibition grounds without fatigue. The proposed train is to consist of low railway trucks carrying a simple timber platform, the rails being laid in a trench, as shown in section in Fig. 2. The total length of the proposed line is 2,080 metres. The horse-power required is estimated at 640, and it is proposed to work the train by electricity. There is to be a complete system of telephones, by means of which the attendants can at any moment cause the train to be stopped if required. We cannot help thinking that other precautions will be necessary, especially to prevent overcrowding.

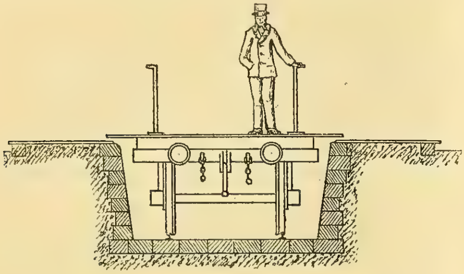


Fig. 2.—Section of Moving Platform.

## THE CHEMICAL SECTION AT THE MANCHESTER EXHIBITION.

NOT only from a local, but from a national point of view the display of chemical products at this exhibition is one of considerable importance. It brings vividly before us the enormous strides made in the chemical industry, and while reflecting that this great advance has been going on quietly in obedience to the simple law of supply and demand, we see that it involves not only a development of chemical manufactures, but of the trades in which the chemicals are used, and of the hundred-and-one allied branches of trade. A not unimportant benefit from this great manufacturing progress, is also the employment it gives to an immense number of men, women, and children in our overstocked country.

We refrain from mentioning in detail the exhibits in this most instructive section, as this is already being done by the technical journals, and we will content ourselves with notes on some of the exhibits which are more generally interesting. In the hygienic group there are several useful antiseptic preparations, and a considerable number of well-known disinfectants and deodorisers. Among the latter are Jeyes' sanitary compound, which has just been reported on by Professor Attfield, F.R.S., who has tested it in dwellings, out-houses, drains, etc., and who says that it answers as well as carbolic acid, while it is much cheaper, and is perfectly miscible with water. He adds that a carefully conducted series of experiments showed that microscopic germs, such as bacteria, bacilli, etc., were killed in a few minutes, and in some cases instantly, by a five per cent. mixture of the disinfectant with water, and very quickly by a one per cent. solution. There is a very fine display of coal-tar products used chiefly for dyeing fabrics, and seeing that the first aniline dye (mauve) was discovered by Dr. Perkin under thirty years ago, the great and increasing development of this industry is very remarkable. Great, however, as has been the advance in this branch of manufactures, it will be well for us not to forget that Germany has now outstripped us in the supply of these very materials, which our chemists taught them to make. This we referred to in our last number, and as this exhibition affords proof of what can be done in England, we sincerely trust that every effort will now be made on the part of our manufacturers to recover their lost ground.

A great development has also been made in the manufacture of pigments and paints. Artificial ultramarine, for instance, is of comparatively late origin, and although it is now used largely, up to about fifty years ago it was only obtained in very small quantities from lapis lazuli by a process of grinding and rinsing, which was at once tedious and expensive. In the year 1824, a prize was offered in France for the discovery of a chemical process for obtaining artificial ultramarine, and in 1828 it was awarded to Gmelin, of Tübingen. About the same time a process was also discovered by Guinet, of Toulouse. Ultramarine is now manufactured in France, Germany, and England, and is extensively used in paper making, calico printing, painting, laundry work, etc. At the exhibition, Mr. Charles Scheu not only shows excellent specimens of ultramarine colours (blue, green, and violet), but he also shows a model furnace for manufacturing ultramarine, and a collection of the raw materials used in the process. Messrs. Rawlins and Son also show good specimens of ultramarine in various stages of manufacture. This firm were the first to establish works for making it in England, and from time to time they have introduced important improvements in the processes. Mr. Henry Crookes shows a heat-indicating paint, which is a brilliant red, and has the property of gradually becoming darker when heated, until at about 140° Fahr. it assumes a dark brown colour; on cooling it regains its original tint. It is said that if this paint is applied to the bearings of a machine or engine, it will act as a tell-tale of temperature, so that the attendant need not have to feel them constantly with his hand.

Many attempts have from time to time been made to devise a non-poisonous substitute for ordinary white lead paint, which often so injuriously affects the painters who use it, and especially those who are engaged in its manufacture. The poisonous effects produced are believed to be mainly due to the diffusion of the carbonate of lead in a pulverulent form in the workshops, so that besides being inhaled, it collects upon the hands, and is carried into the mouth with the food. Ordinary white lead consists largely of carbonate, which is readily acted upon by some of the acid juices of the body, but sulphate of lead is practically insoluble, and is supposed to be innocuous. Hitherto the drawback to the use of sulphate as a paint has been that it was too sticky, and could not be worked well with a brush. About three years ago Messrs. J. B. Freeman and Co. introduced a sulphate of lead paint of the density and consistency required to take the place of ordinary white lead, and were it not for the ignorance and consequent prejudice of workmen we believe it would be more largely used than it now is. It has been favourably reported on by several scientific authorities, it has the approval of the Government inspectors, and its cost is about the same as that of its more dangerous rival. Messrs. Griffiths and Co. also show a non-poisonous paint, but of a different kind. Theirs is made from sulphide of zinc, which is said to be greatly superior to the zinc-white, made from oxide of zinc. This firm also has a fire-proof paint, which was adopted for the exhibition building after being tested at the Owen's College. These tests showed that it does not contain silicate of soda, or anything that will cause an efflorescence, or make it crack or peel. Messrs. Donald Macpherson show a kiosk made of bricks covered with enamelled paint, also specimens of zinc, wood, and stone coated in a similar manner, and to prove that it will dry on a greasy surface they have actually coated some tallow candles with it. Among the varnish exhibits is a very noticeable one of Messrs. Ingham, Clark, and Co. It consists chiefly of a collection of fossilised resins and gums used in the manufacture of varnish, and among them are beautiful specimens of gum amber from the shores of the Baltic, gum mastic from the island of Chios, gum animi from Zanzibar and Demerara, and gum kaori from New Zealand. The last named weighs about 200 pounds, and is the largest specimen yet discovered; the gum animi from Demerara is also particularly interesting, as it has embedded in it a large number of ants and other insects.

In the metallurgy group Mr. Percy C. Gilchrist has a good collection of steel and slag made from phosphoric pig-iron by the Basic or Thomas-Gilchrist process, and in the same group the College of Agriculture, at Downton, exhibit a chart showing the effects of basic cinder used as a fertiliser. This subject, however, will be treated of in our next issue in a separate note, kindly sent us by a professor of the college. The Magnesium Metal Co. have a very interesting and choice collection of antimony, bismuth, magnesium, quicksilver, potassium, sodium, vanadium, and other rare and interesting metals. Their manufactured products are also well worth examination. Messrs. J. Walker, Parker and Co. show specimens of lead ore, and of the products and manufactures for which they have such a deservedly high reputation. A novelty shown by them is an oval pipe for resisting the effect of frost, and specimens are exhibited of round and oval pipes of the same size, which have been subjected to the same freezing temperature. The round pipe burst after two or three freezings, but the oval pipe resisted many more freezings before showing signs of injury. Messrs. H. Wiggin and Co. show specimens of nickel and cobalt ores from Hungary, Norway, and New Caledonia, also articles produced from them in various stages of manufacture. They also show some fine specimens of the oxides of cobalt used in the potteries for obtaining a beautiful blue colour; they also have a new substance, carbonate of cobalt, used in the arts, and a soluble oxide of nickel used for making nickel salts.

Among the Alkalis and Acids, Messrs. J. Riley and Sons show samples of sulphuric acid made from brimstone, and to get it pure they concentrate it in platinum vessels instead of lead. Specimens of these vessels are shown in an adjoining case by the makers, Messrs. Johnson, Matthey and Co., and are specially deserving of attention. Messrs. Gaskell, Deacon and Co. have a fine set of samples of their special make of crystallised carbonate and bicarbonate of soda made direct from the vat liquor, besides other chemicals used for bleaching and washing. Messrs. Bell Brothers show samples illustrating the salt deposits and industry of the Tees, an account of which will be found in Sir Lowthian Bell's paper just read at the Institution of Civil Engineers. Messrs. Peter Spence and Sons have a really fine display of alum, such as is used by paper makers, dyers, calico printers, pottery colour manufacturers, and others: also sulphate of alumina and some special compounds used by dyers and others. They also exhibit a proposed international hydrometer, to be used as a standard measurer both of the strength and the specific gravity of solutions and other liquids. We hope to give a more detailed description of this another time. The Widnes Alkali Co. show fine specimens of their well-known caustic soda, bleaching powder, etc. The caustic soda trade is another instance of remarkable development: within the last twenty-two years it has increased from about 100 tons a week to about 3,000 tons a week. The Widnes Co. alone make about 650 tons a week, and have three of the largest revolving furnaces in the world. Caustic soda is chiefly used by paper makers and in the manufacture of soap. Wood pulp is also used by paper makers as a substitute for rags, and Messrs. Newall and Son show specimens made by grinding the wood mechanically; they also make pulp by treating the wood with caustic soda or other chemicals, and these processes are preferred to the mechanical one. The wood is chiefly imported from Norway and Sweden.

In conclusion, we strongly recommend our readers to inspect this very important section of the exhibition. It is impossible for us to deal thoroughly with the very varied collection it contains, but the examples we have cited are sufficient to show how much there is to interest not only the chemist, but others who desire information on many important branches of our national industries.

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MENTAL WORK.—There is as much danger of hurting the brain by idleness as by overwork, for intellectual power is lessened by the listlessness in which the well-to-do classes so often spend their lives. Under such conditions the brain gradually loses its health, and although equal to the demands of a routine existence, it is unable to withstand the strain of sudden emergency. When therefore work is unexpectedly thrown on it in its unprepared state, the worst consequences of what may be called overwork show themselves. Similarly, a man accustomed to sedentary pursuits is liable to be physically injured by suddenly taking too violent exercise. As to the amount of mental work that may be safely done, Dr. Farquharson says:—"So long as a brain worker is able to sleep well, to eat well, and to take a fair proportion of out-door exercise, it may safely be said that it is not necessary to impose any special limits on the actual number of hours which he devotes to his labours. But when what is generally known as worry steps in to complicate matters, when cares connected with family arrangements, or with those numerous personal details which we can seldom escape, intervene; or when the daily occupation of life is in itself a fertile source of anxiety, then we find one or other of these three safeguards broken down."

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## APPARATUS FOR COMPRESSING OR EXHAUSTING AIR.

THOSE of our readers who are accustomed to laboratory work are well aware that it is frequently necessary to compress or exhaust air for certain operations. For instance, a blow-pipe requires a supply of air at pressure, and this is produced either by the mouth, by a foot-blower, or by mechanical means. When suction is required, an aspirator is generally used, as shown in Fig. 1. In this the vessel A is first charged with water by taking out the stopper *s*; the stopper is then replaced, and the tube *t* is connected with the apparatus to be exhausted. If the cock *c* is then opened, and water is allowed to run out, the pressure within the vessel A is reduced below that of the atmosphere, and a suction is caused in the direction of the arrow *e*. This is suitable for operations of short duration, in which very little power is required; but for many purposes it is insufficient, and an expensive pneumatic apparatus is necessary.

In a recent number of *La Nature*, attention was called to an apparatus made by M. Alvergniat, of Paris, in which use is made of a continuous stream of water at the pressure obtained from the street mains, for the purpose of exhausting or blowing. This apparatus is shown in Fig. 2, and may be thus described: When the tap *a* is opened water from the main passes through the two cones *b* and *c* and then into the vessel A through the tube *f*; the cock *g* should then be opened, to allow the water to pass, and if, at the same time, the cock *d* is open, air will be sucked in and carried forward by the water into A. The principle is, in fact, that of the well-known injector, in this case worked by water instead of steam. The air, being lighter than the water, rises to the upper part of A, and, as the water is under pressure, it in turn compresses the air. If the cock *e* be opened, there will therefore be an escape of air at pressure, and this can be used for blow-pipe or other work. If, on the other hand, the tube *d* be connected with any apparatus requiring exhaustion, the suction produced at *d* will effect this purpose. It is said by *La Nature* that the first design for this apparatus was made in 1872 by M.

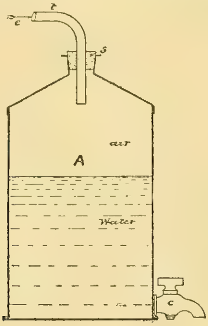


Fig. 1.

Lane (a pupil of M. Sainte-Claire Deville), and that he first used it at the Sorbonne laboratory.

It is, however, somewhat singular that an apparatus similar in principle was long ago devised by Sir Charles Cameron, the Medical Officer of Health and Public Analyst for Dublin, ex-President of the Royal College of Surgeons in that city. In fact, it has been in use since 1871 in the

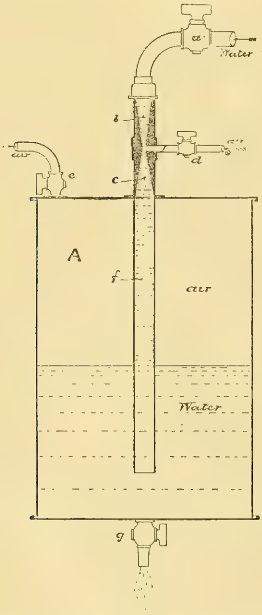


Fig. 2.

college laboratory, and, as we have seen it in operation there and know it to be simple and efficient, we think it is due to its inventor that it should be mentioned; at the same time, some of our readers may be glad to know of it. The apparatus referred to is shown in Fig. 3, in which *a* is the tap for admission of water from the street main; *b* is an upper and *c* a lower cone, by means of which air is sucked in through *d*, and forced through the tube *f* into the vessel A, when the water is turned on; *g* is a syphon for drawing off water from A, and *h* is an air-vent to prevent the flow of water being checked by an accumulation of air. When the cock *e* is opened, there is an escape of air at

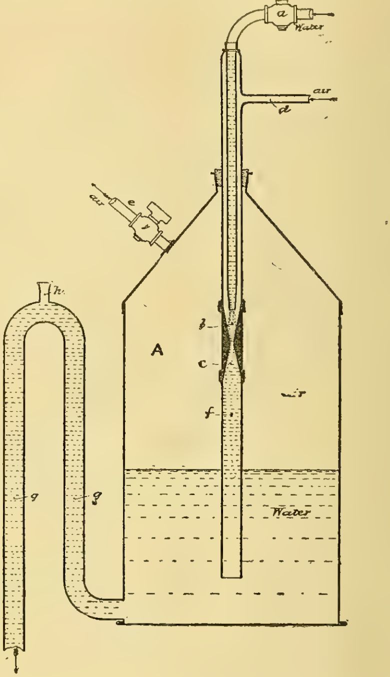


Fig. 3.

pressure, which is used for blow-pipe and other work, and when required the tube *d* is connected with any apparatus requiring exhaustion, as in Fig. 2.

It will thus be seen that there is a remarkable resemblance in the working of the two apparatus, and that both of them are designed to give identical results.

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THE ACCIDENT AT CRARAE QUARRY.—A bluebook has been published, containing the report of Colonel A. Ford, Her Majesty's Inspector of Explosives, on the explosion at Crarae Quarry, Loch Fyne, on September 25th last year. It will be remembered that a large party went on a steamer to see the effect of some blasting operations in the quarry, and that after the explosion they visited the spot. Many of them were seized with faintness; six were dead when rescued, one died afterwards, and five others were conveyed to the infirmary at Greenock, where they recovered. Colonel Ford gives in minute detail the gases which must have escaped after the explosion of 13,000 lbs. of gunpowder, and describes the symptoms which were developed in the injured persons. Probably, Colonel Ford says, the mischief was done by the carbonic oxide—of which 468 lbs. were generated by the explosion, an amount which, at the ordinary temperature and pressure, would occupy a space of 6,333 cubic feet. This would be sufficient to vitiate one hundred times as many cubic feet of air, but in the presence of carbonic anhydride—of which 3,575 lbs. were generated—it would render 1,266,600 cubic feet fatal to human life.

## THE TECHNICAL TRAINING AT THE CENTRAL INSTITUTION.

PROFESSOR AYRTON, F.R.S., recently gave an address on the above subject at a well-attended meeting of the leading advocates of technical education, Professor Huxley being in the chair. After some introductory remarks, the lecturer said that in our grandfathers' days, nay, even in our fathers', the only subjects that were deemed fit to be studied by a gentleman were classics and mathematics. It was, he supposed, accepted then, as it certainly was now, that the two objects of mental training were, first, that the reasoning power might be cultivated, second, that the mind might be stored with knowledge. If so, then the impression must have existed that the means adopted for obtaining the one result could not be employed in securing the other. The working out of puzzles with the aid of classical grammars and dictionaries was the recognised and stereotyped process for the training of the reasoning power, and that the information thus obtained would probably be of no use whatever to the student in his practical life, appeared to constitute the most certain proof of its value in the eyes of the many.

For a lad of a practical turn who was not fond of abstract reasoning, could it be a profitable course of study that told him he might take for granted that the whole is greater than the part, but not the equally obvious fact that two sides of a triangle were greater than the third? Was it in his nature, Professor Ayrton asked, to sympathise with his instructors when they refused to allow him to regard certain obvious facts as true until they had been proved by a rather elaborate train of reasoning, which did not make the facts one bit more certain? But that was the study of Euclid, a study that seemed to him to resemble some game that was played according to rules which were quite arbitrarily selected, and which those who aimed at advance not unnaturally refused to be shackled by. The playing of this mathematical game he felt at liberty to criticise, because it was most enchanting to him in his boyhood, and was one in which he was generally the winner. He supposed, therefore, that he saw the best side of it, but that did not blind him to the fact that his comrades were not enthusiastic about its merits, nor make him forget the attitude it led him to take with reference to experimental science.

It should not be supposed that he was decrying the study of mathematics; what he was opposing was the study of mathematics as an *end*. Mathematics was one of the most useful and powerful weapons the natural philosopher possessed, but it was no use spending all one's time making guns and learning how to load them, if they were not now and then to be fired off. While, therefore, mathematics was being taught in one part of a school or college, its use should be taught in another, and the more valuable the student found that mathematics was to him in the practical side of his work, the more eager would he be to master it. Some of the greatest inventions that had been made—the improvements in the steam engine by Watt, the construction of the locomotive by Stephenson, the discovery of the mechanical production of the electric currents by Faraday, or, coming to more modern times, the telephone, the microphone, the phonograph, and the incandescent lamp—were not the outcome of the universities or of university training. In fact, theory, unaided by experience, showed the impossibility of a simple speaking machine, and so hindered rather than aided the invention of the phonograph. Gradually the study of science was introduced into English schools and colleges, but natural philosophy, that is the philosophy of nature, was mainly taught mathematically and unnaturally; the experimental course, if there were one, being relegated to those who were weak in their mathematics. Even in this course the students never touched the apparatus themselves, so that this so-called experimental course was no more an education in the methods employed in attacking new physical problems, and in overcoming the difficulties encountered in experimental research, than occasionally seeing the Beckwiths performing feats in the water tank, illuminated by the lime-light, can be considered as a training in swimming. Rapidly, too, the experiments shown at the lectures became classical; it was an historical and not a living science that came to be taught.

Technical education had been defined as teaching people to apply science to industry; not only by means of technical education is the practical man trained to use his brain when he uses his hands, but what is quite as important for the country's welfare, the scholar, by receiving technical education, learns to use his hands when using his brain. Technical education, then, was not only the means by which scientific knowledge might be acquired by the manufacturing class, who, starving for lack of a food that they had hitherto so little valued, were allowing England's greatness to depart for other shores, but it also put the scholar *en rapport* with his country's needs, and showed him what were the battles waiting to be won with his all-powerful mathematical and scientific weapons.

Darwin had shown us what was the result of a struggle for existence; it led to the survival of the fittest. Are, then, the English people the fittest? What about the lace curtains, he asked, the web of which is made in England, but which, before they can be sold in England, have to be sent to France or Belgium to have the pattern put on, because we have not the requisite machinery? What about the steamers built on the Clyde for the German nation, which as soon as they can just float are manned by a crew sent from Germany, and taken over to that country to have their interiors fitted, because this can be done better and more cheaply in Germany than in England? What about the watch industry? In 1856, he believed it was, England made watches for the whole world, and now it imports large numbers yearly from Switzerland and America. He should, perhaps, be answered that that was because Continental workmen would work for a pittance that English workmen scorned, but did that apply to the Waltham watch, the Waterbury watch? Was America so noted for low wages? If any proof were wanting that the real explanation was the greater technical knowledge, the greater belief in the necessity for improvement that existed among the Americans, the display at the Inventions Exhibition of the whole process of turning out Waltham watches would furnish it. While we were saying to ourselves that our fathers' ways should be our ways, the American guessed that the very fact of any particular process having been used by those before him was a sufficient reason for concluding that he could arrive at a better one. No doubt we were handicapped by the fact that vast sums had been spent in machinery in England, which our manufacturers were loth to discard, even although it would only turn out articles that had gone out of date and were totally unsaleable. And curiously enough some preferred continuing to make these articles (and to regard the want of business as due to over-production) to laying out capital on new modern machinery which a country taking up the industry starts by buying. But this was not a sufficient explanation. England had money enough to make or buy the very best machinery when it recognised the importance of having it; and one of the results of the technical education which the manufacturers' sons, who were beginning to come to the Central Institution, were receiving there, would be to bring about a recognition of the fact that not only to maintain the lead, but even to keep directly in the front, not merely the men but also the manufacturers must arm themselves with technical knowledge, to enable them to effect the improvements in their machinery and processes which progress demanded of them.

Looking at the entire work which the City and Guilds of London Institute had carried out during the last eight years, one saw how much larger it was than the work it started to accomplish, but that was not on account of more having been done at the Central Institution than was contemplated in the scheme of organisation, but because the efforts of the Institute in other directions had led to wider developments than were originally anticipated. The very fact that the Institute had already done much more at Finsbury than was originally contemplated, and that it had carried out so large a part of the scheme of organisation at the Central Institution, assured him that the Institute would not only enlarge the buildings at Finsbury, which was much needed, but that it would complete the remainder of the scheme at the Central Institution which also was urgently necessary to make the work a connected whole.

In his own department, Professor Ayrton said he should like to see the teaching in optics rendered as valuable to the optical instrument makers as was possible, but to do that would require someone with a knowledge of the exact devices used in the trade, and a comprehensive knowledge of the theory, to devote himself to making the one help the other. He should further like to see the subject of warming and ventilation made a science. The warming and ventilation of buildings was at present carried out in far too empirical a manner, and consequently the result was often failure. To make that subject a science would require some one to devote himself to it, spending all his time teaching what he knew, and with the students experimentally finding out what probably neither he nor anyone else yet knew. It appeared to him that it would be but little more difficult to obtain accurate practical rules about the flow of heat and of air, than it had been to obtain the accurate practical rules which the electrical engineer made use of daily. And although he should not like even to suggest that the science of electrical engineering was within measurable distance of perfection, still he did not think that in any electric light installation an electric current would be found to flow in the opposite direction to that anticipated by the electrician, whereas, in connection with ventilation, openings put in the wall to act as inlets not unfrequently acted as outlets. The professional constructor of ventilating and warming appliances was certainly at present far behind the electrical engineer. He had been told that the cold draughts or stifling atmosphere in public buildings arises, in some cases, from the architect having been himself compelled to design the ventilating and warming arrangements without possessing sufficient knowledge of the subject, or from his having constrained the person who had done the work, by imposing conditions of art. But, if this were the case, or even if there were the shadow of plausibility in this statement, then he would appeal most earnestly to the architects to join hands with those whose duty and whose aim it was to advance technical education in helping young architects to obtain a far wider technical knowlege than was thought necessary in the past. It was to the interests of the architectural profession that they should gain this knowledge; it was the province of the Central Institution to give it. There was another branch of physics which concerned the architect, and that was acoustics. Books on acoustics usually contained a great deal about the vibration of strings, tuning-forks, and organ pipes, in fact they appropriated the name to the science of music and left out the equally important science, the science of noise. It was perhaps not particularly interesting to an architect to know how a string vibrated when emitting different musical notes, he might not care about the fact that the tuning-fork gave a fairly pure note without harmonics, but it was all important to him to keep a sound on that side of a wall on which it was produced. What a mine there was for some architect who would study what Tyndall had done on stoppage of sound, and, by earnest experimenting, work out a method of rendering our walls nearly as impervious to sound as they were now to light.

The address was concluded by the following quotation from a speech of the Lord Chancellor, at the opening of the Central Institution in 1884:—"The Englishman has yet to learn that an extended and systematic education, up to and including the methods of original research, is now a necessary preliminary to the fullest development of industry."

## REVIEWS OF BOOKS.

*Minutes of Proceedings of the Institution of Civil Engineers; with other Selected and Abstracted Papers.* Vol. lxxxviii. Edited by James Forrest, Assoc. Inst. C.E. London: Published by the Institution. 1887.

This volume of the Proceedings of the Institution of Civil Engineers contains three important papers that were read and discussed during the session to which the issue refers. The first of these is a valuable contribution from Professor A. B. W. Kennedy, on "The Use and Equipment of Engineering Laboratories." Professor Kennedy, as the head of the engineering laboratory at University College, has taken a leading part in the establishment of such institutions, and no one is better qualified to speak on the subject. The paper describes the method of work, the nature of the experiments made, and the apparatus used. The section treating of testing machines, is especially valuable, and is well illustrated. The discussion on this paper was of that thorough and satisfactory nature which a good subject always ensures at the meetings of the Institution. Two evenings were devoted to it, and a large proportion of the best authorities on the question were heard. The method of dealing with papers followed by the Civil Engineers is an agreeable contrast to that of some other kindred societies. With the latter all papers, good and bad, important or unimportant, are treated alike, and when four or five contributions are heard at one sitting, it is impossible to do them justice. The Civil Engineers, on the other hand, select a few papers for reading and take the others as read, printing them in the Proceedings. It does not of course follow that the latter are not valuable, but simply that they are not so suitable for discussion. Another excellent feature in the Proceedings of this Institution is the correspondence that is invited and published with the discussion. Very often members or others may have valuable information to give, but are unable to be present in the theatre. The incorporation of correspondence enables such information to be made use of, whereas it would be otherwise lost. It is true that, with other technical societies of a kindred nature, letters are occasionally incorporated with the discussion, but with the Institution of Civil Engineers no pains are spared to bring the question before as many persons competent to speak on the subject as possible, and get their opinions and ideas. It is these facts that render the Proceedings of this Institution so valuable. Too much is never attempted, but whatever is done, is done completely and satisfactorily. The other two papers referred to are on "Sewage Sludge, and its Disposal," by W. J. Dibden, and "Irrigation in Lower Egypt," by W. Willcocks. The selected papers (unread) are on "Harbour Works in Algoa Bay," W. Shield; "Friction Clutches," W. Bagshaw; "Iron and Brass Foundries of Point St. Charles Works, Grand Trunk Railway of Canada," F. L. Wanklyn; "Utilizing Waste Air in Filter Presses," J. Hethrington; "Administration of Fishing Boat Harbours in France," "Central Station Electric Lighting," K. W. Hedges; "Skeleton of Statue of Liberty, New York," T. Seyrig; "Syphon Outlet for a Low Sewer District," G. E. Waring, Junr. The abstracts of papers in foreign transactions and periodicals, which are so valuable a feature in the published minutes, form a fitting conclusion to the work.

## THE ROYAL INSTITUTION.

### LIGHT AS AN ANALYTICAL AGENT.

AT a recent lecture, given by Professor Dewar, he said that many questions arose in the progress of research which were perhaps to be considered rather as side issues than actually coming in due sequence. Thus there were two conditions of study—the action of light on matter, and the action of matter to produce light. The latter, as was known, could be effected in many different ways, but the recent methods by which the action of light on matter had been studied had shown that light was such an exceedingly refined agent that it was doubtful how it would have to be regarded in future. In effecting some decompositions, its action appeared to be instantaneous. Among the many puzzling problems that had lately arisen were those in connection with electric discharges in high vacua. When carbon was used as an electrode, a carbon compound was the result, but the question was, Where did the oxygen come from? Could it be that it came from the glass? Many most interesting conclusions had been drawn from vacuum tubes, but a most important consideration was whether what was seen was rightly interpreted. Again, much reliance was placed on the spectra of bodies to tell us of changes they underwent; but, after all, what were the spectra, and what were the molecular changes of which the spectra were the result? The path in which it was hoped, perhaps, to find some answers was that of Stass, of Brussels.

## THE SOCIETY OF ARTS.

### THE CHEMISTRY OF PUTREFACTION.

IN the second Cantor lecture on this subject given by Mr. J. M. Thomson, he said Ammonia is produced in the decomposition of organic substances containing nitrogen, whilst sulphuretted hydrogen and carbonic acid are also common products of decomposition. When coal is subjected to dry distillation, all these bodies are formed. Animal substances contain frequently the element phosphorus, in addition to those mentioned. Animal matter undergoing decomposition produces what are known as ptomaines. They are poisonous nitrogen bases, similar to the vegetable alkaloids, and can be recognised by the same general tests. Iodine, dissolved in iodide of potassium solution, gives a distinct precipitate of the alkaloid itself. Hair, wool, nail, and horns also yield large quantities of ammonia, as a result of their decomposition. Hydrogen is also liberated under certain conditions of decay, and at the moment of its liberation is capable of reducing phosphorus compounds, and forming with them phosphoretted hydrogen, a gas which is characterised by phosphorescence; and it is, therefore, probable that the phosphorescence of some organic bodies is due to this cause. Sulphuretted hydrogen is found in numerous putrefactions, and is produced, probably, in a similar manner. It exists in sewer gas, and can be recognised by the blackening of paper, which has been moistened with a solution of some soluble lead or silver salt. The amount of sulphuretted hydrogen present can be estimated by the intensity of the colour produced, as compared with standard colours. Minute quantities, such as that present in a single human hair, are recognised by the violet colour produced with it by a solution of sodium nitro-prusside in strongly alkaline solution. Marsh gas and olefiant gas are two hydrocarbons which are also produced in decay, the former existing in the bubbles of gas evolved from the bottom of stagnant ponds. Ammonia, as already mentioned, is a frequent product of decay, and from its solubility in water, affords an indication of former putrefaction. The compound ammonias, ethylamine, propylamine, and butylamine—are formed in the decay of such substances as flour, herring roe, etc. Bones, when distilled, similarly yield several of these compound ammonias. Putrefying flour yields also trimethylamine and amylamine, which are bodies belonging to the same group of substances. Nessler solution serves to identify the presence of ammonia, if formed in matter undergoing decay. The compound ammonias can be decomposed into ammonia by boiling with potash, and so recognised by the same test. Ammonia, on oxidation, yields nitrogen, nitrites, or nitrates. In nature, when the oxidation proceeds slowly, nitrites and nitrates are the products of the change; nitre beds, which exist in large quantities in sub-tropical climates, are produced in this way, by the nitrification of ammonia in the presence of bases such as potash and lime.

## THE INSTITUTION OF CIVIL ENGINEERS.

### THE MANUFACTURE OF SALT NEAR MIDDLESBROUGH.

AT the ordinary meeting on Tuesday, the 17th of May, the paper read was "On the Manufacture of Salt near Middlesbrough," by Sir Lowthian Bell, Bart, F.R.S., M.Inst.C.E. The geology of the Middlesbrough salt region was first referred to, and it was stated that the development of the salt industry in that district was the result of accident. In 1859, Messrs. Bolckow and Vaughan sank a deep well at Middlesbrough, in the hope of obtaining water for steam and other purposes in connection with their ironworks in that town, although they had previously been informed of the probably unsuitable character of the water if found. The bore-hole was put down to a depth of 1,200 feet, when a bed of salt rock was struck which proved to have a thickness of about 100 feet. At that time one-eighth of the total salt production of Cheshire was being brought to the Tyne for the Chemical Works on that river; hence the discovery of salt instead of water was regarded by some as the reverse of a disappointment. The mode of reaching the salt rock by an ordinary shaft, however, failed, from the influx of water being too great, and nothing more was heard of Middlesbrough salt until a dozen years later, when Messrs. Bell Brothers, of Port Clarence, decided to try the practicability of raising the salt by a method detailed in the paper. A site was selected 1,314 yards distant from the well of Messrs. Bolckow and Vaughan, and the Diamond Rock-Boring Company was entrusted with the work of putting down the hole. This occupied nearly two years, when the salt, 65 feet in thickness, was reached at a depth of 1,127 feet. Other reasons induced the owners of the Clarence Ironworks to continue the bore-hole for 150 feet below the bed of salt; a depth of 1,342 feet from the surface was then reached. During the process of boring, considerable quantities of inflammable gas were met with, which, on the application of flame, took fire at the surface of the water in the bore-hole. The origin of this gas, in connection with the coal measures underlying the magnesian limestone, will probably hereafter be investigated. For raising the salt recourse was had to the method of solution, the principle being that a column of descending water should raise the brine nearly as far as the differences of specific gravity between the two liquids permitted—in the present case about 997 feet. In other words, a column of fresh water of 1,200 feet brought the brine to within 203 feet of the surface, and it was then pumped up.

## THE GEOLOGICAL SOCIETY.

A MEETING of this Society was held on May 11, Prof. J. W. Judd, F.R.S., president, in the chair. The following communications were read:—

(1) "Further Observations on *Hyperodapedon Gordoni*." By Prof. T. H. Huxley, LL.D., F.R.S., F.G.S. The author briefly noticed the circumstances under which he first described the occurrence of Lacertilian and Crocodilian fossils in the Elgin Sandstones, and the confirmation which his views as to the Mesozoic age of these remains had received from the discovery of *Hyperodapedon* in English Triassic rocks and in India. The original type of *Hyperodapedon Gordoni* from Elgin was, however, in bad condition, and the receipt at the British Museum of a second much better preserved skeleton, found in the Lossiemouth quarries of the same neighbourhood, had enabled him to add considerably to the known characters of the genus, and to compare it more thoroughly both with the recent *Sphenodon* (or *Hatteria*) of New Zealand and with the Triassic *Rhynchosaurus articeps*, several specimens of which are in the British Museum palæontological collection.

(2.) "On the Rocks of the Essex Drift." By Rev. A. W. Rowe, M.A., F.G.S. The rocks of the drift in Essex are of such great variety that it is difficult both to get a really representative collection and to classify them when they have been collected. About two hundred specimens have been taken, and sections have been made of one hundred and fifty of these. There is a remarkable absence of granite of any kind, and only two specimens of syenite have been found. Quartz-porphyrites and quartz-tourmaline rocks are fairly abundant, felsites are rarely met with, but felspar porphyrites are very abundant; trachytes also are found, but there is some reason for suspecting that these do not really belong to the drift, but have been imported in very early times. The most abundant of the igneous rocks are the dolerites; but all the coarser dolerites and those of a true ophitic character are wanting. Many of the specimens are of subophitic texture, and bear a general likeness to the subophitic dolerites of Central England, though without having any special points of resemblance; some of the specimens, however, are strikingly like the rocks of the Whin-Sill, and that too in certain special points. The dolerites of trachytic texture, or basalts, do not at all resemble those of the North of England, but some of them are almost identical with certain Scandinavian basalts.

(3.) "On Tertiary Cyclostomatous Bryozoa from New Zealand." By Arthur W. Waters, Esq., F.G.S. The Cyclostomata noticed in this paper were from the same collections as the Chilostomata described in the last volume of the *Quarterly Journal*, and this part was kept back a short time, in the hope that the publication of the report of the *Challenger* expedition might throw some light upon this unsatisfactory suborder; but the results are very disappointing in this respect, as only thirty-three species are recorded, and these are for the most part well known and common ones. The author recorded the preservation of the extremely delicate and fragile rays or "hair-like teeth" in the interior of the fossil *Entalophora intricaria*.

Out of the twenty-eight species or varieties eighteen are known living, and this part of the collection agrees with the former in indicating that it is comparatively recent. The number of these fossil Bryozoa is now brought up to 106.

## ROYAL METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on the 18th May, at the Institution of Civil Engineers, Mr. W. Ellis, F.R.A.S., President, in the chair. The following papers were read:—

(1) "Brocken Spectres and the Bows that often accompany them," by Mr. H. Sharpe. The author has collected all the original descriptions of the Brocken Spectre, which is really the shadow of the observer cast by the sun upon clouds. In some cases the shadow is surrounded by a bow, which the author shows is like the rainbow in colour and in the order of colours. The head of a shadow is sometimes surrounded by another sort of phenomenon touching the head, and which the author names the "glory."

(2) "Results of Thermometrical Observations made at 4 ft., 170 ft., and 260 ft. above the ground at Boston, Lincolnshire, 1882-6," by Mr. W. Marriott, F.R.Met.Soc. These observations were made on Boston Church tower, which rises quite free from any obstructions, in a very flat country, to the height of 273 feet. A Stevenson screen with a full set of thermometers was placed four feet above the ground in the churchyard, a similar screen and thermometers was fixed above the belfry at 170 feet above the ground, while a Siemens electrical thermometer was placed near the top of the tower, the cable being brought down inside, and attached to a galvanometer on the floor of the church, where the indications were read off. The results showed that the mean maximum temperature at four feet exceeds that at 170 feet in every month of the year, the difference in the summer months amounting to 3°; while the mean minimum temperature at four feet differs but little from that at 170 feet, the tendency, however, being for the former to be slightly higher in the winter and lower in the summer than the latter. As the electrical thermometer was read usually in the daytime, the results naturally showed that the temperature at four feet during the day hours was considerably warmer than at 260 feet. The author, however, detailed several sets of readings which had been made during the night as well as the day, the results from which were of a very interesting character.

(3) "Snow Storm of March 14th and 15th, 1887, at Shirenewton Hall, near Chepstow," by Mr. E. J. Lowe, F.R.S.

During the evening the President made a presentation to Dr. J. W. Tripe of a silver tea and coffee service, which had been subscribed for by the Fellows in acknowledgment of the many services which he had rendered to the Society during a period of over thirty years.

## ROYAL MICROSCOPICAL SOCIETY.

ON April 13, Rev. Dr. Dallinger, President, in the chair, Mr. T. C. White exhibited a series of photomicrographs which he had recently taken, showing the result of the method of cutting off some of the superfluous light by means of a sliding diaphragm, so as to be able to admit just enough to bring out the detail and nothing more. The specimens shown were printed on Eastman's bromide paper instead of silver paper, which he found brought out the character of the detail very much better. Mr. F. R. Cheshire called attention to some specimens of bees, known as "fertile workers." It was generally well known that in the bee-hive all the eggs were usually laid by the queen, and in her absence no ovipositing occurs until they have taken some of the eggs remaining in the hive, and by a special feeding of the larvæ have been able to produce fresh queens. If, however, it should happen that in a hive which has lost its queen there are not eggs available for this purpose, it was found that some of the workers under some special circumstances which could not be very clearly explained, became capable of laying eggs, but that such eggs produced drones only. These bees were known as fertile workers, and though there could be no doubt as to their frequent existence, they were very difficult to catch, owing to their being the same in appearance as the ordinary workers. He now exhibited two of these fertile workers, having the ovaries drawn out of the bodies and attached to the stings and abdominal plates so as to show that they really were workers. There was a remarkable peculiarity to be observed in connection with the ovarian tubes of these insects—every ordinary worker possessed an undeveloped ovary which it was very difficult both to detect and dissect, but when under the influence of some stimulus the worker became fertile, a number of points began to appear in the tubes, which afterwards became developed, and it would seem that the eggs were developed in alternation, an examination of the tubes showing them to contain developed eggs alternating with others in an undeveloped condition, and of which some very curious instances were seen in the specimens before the meeting.

Mr. Crisp called attention to photomicrographs of animalcules sent by Mr. J. B. Robinson; and to photographs of snow-crystals sent by Mr. Waters, from Davos Platz; also to a specimen of one of the earliest forms of the compound microscope by Campani, of Rome, made some time prior to 1665. A new form of adjustable nose-piece, by Dr. Zeiss, was exhibited, in which the objective was made to slide in a groove in an inclined plane which insured its not scraping along the surface of the cover-glass when being changed. A paper by Mr. P. H. Gosse, on twelve new species of Rotifera, was read.

## THE SOCIETY OF CHEMICAL INDUSTRY.

### NEW PROCESS OF MANUFACTURING WHITE LEAD.

AT the sixth meeting for the session of the Glasgow and Scottish Section of the Society of Chemical Industry, under the presidency of Mr. J. N. Cuthbertson, Mr. J. Bennett gave an account of a new process of manufacturing white lead as adopted by the St. Mungo Chemical Company, Glasgow. The system, he explained, was managed in such a way, by the aid of automatic machinery, that from beginning to end of the manufacture the material was not handled, and thus the operatives escaped the deleterious effects from which they suffered where the old Dutch process was carried out. Two kinds of white lead were produced at the St. Mungo works—one, the "genuine white lead," and the other a "special" product. The latter, he stated, had none of the disadvantages of the former. It was more dense, and was better in body, covering power, and opacity. It mixed to the same consistency with less oil than the ordinary white lead, did not affect, nor was it affected, by the other pigments used for tinting, and from its chemical nature was not poisonous.

## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE thirty-sixth annual meeting of the American Association is to be held in New York, during the week beginning August 10. The Academy of Sciences has among the local societies taken the lead in the matter of arranging for the reception of the national body, by appointing a committee of conference to secure concerted action among the different institutions of the city. The meeting last year, at Buffalo, was not a very large one, and offered a contrast to the great Philadelphia meeting of 1885. It is hoped that the metropolis will serve as an attraction, and secure the presence, not only of representative American scientists, but of European ones as well.

## RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.

** *The whole of the papers of the Societies referred to are not included in this list.*

### THE ROYAL SOCIETY.

April 28.—Papers read, Note on Dr. G. J. Hinde's Paper on "Beds of Sponge-remains in the Lower and Upper Greensand of the South of England, by Professor E. Hull; "Report of the Observations of the Total Solar Eclipse, of August 29th, 1886, made at the Island of Carriacou," by Rev. S. J. Perry.

May 5.—Papers read, "Note on the Microscopic Structure of Rock Specimens from Three Peaks in the Caucasus," by Professor T. G. Bonney; "On the Distribution of Strain in the Earth's Crust resulting from Secular Cooling, with special reference to the Growth of Continents, and the Formation of Mountain Chains," by Mr. C. Davison; "Note on some Experiments on the Viscosity of Ice," by Dr. J. F. Main.

### THE ROYAL INSTITUTION.

April 30.—Paper read, "The Australian Alps and the Origin of the Australian Fauna," by Professor R. Von Lendenfeld.

May 3 and 10.—Lectures, "Electricity," by Professor Ayrton.

May 5, 12, and 19.—Lectures, "The Chemistry of the Organic World," by Professor Dewar.

May 7.—Lecture, "Recent Researches in Sponges," by Professor R. Von Lendenfeld.

May 13.—Paper read, "Some Electrical Fishes," by Professor J. S. Burdon Sanderson.

May 20.—Paper read, "Bridging the Firth of Forth," by Mr. B. Baker.

### THE SOCIETY OF ARTS.

April 26.—Paper read, "Ornamental Glass," by Mr. J. H. Pollen.

April 27.—Paper read, "Appliances for Saving Life from Fire," by Mr. A. W. C. Shean.

May 2, 9, 16, and 24.—Cantor Lectures, "The Chemistry of Substances taking part in Putrefaction and Antisepsis," by Mr. J. M. Thomson.

May 4.—Paper read, "Agricultural Education," by Mr. J. C. Morton.

May 17.—Paper read, "The West Indies at the Colonial and Indian Exhibition," by Sir Augustus Adderley.

May 18.—Paper read, "Progress in Telegraphy," by Mr. W. H. Preece.

May 24.—Paper read, "The Importance of the Applied Arts and their Relation to Common Life," by Mr. W. Crane.

### ROYAL SCOTTISH SOCIETY OF ARTS.

April 25.—"Report on Mr. Moore's Marine Compass Adjustments"; "Report on Mr. Stephen's Tele-Barometer and Automatic Replacement Indicator." Paper read, "On Booth's Automatic Emergency Brake for Tramway Cars," by Mr. H. Booth.

### THE INSTITUTION OF CIVIL ENGINEERS.

May 10.—Paper read, "The Conversion of Timber by Circular and Band Saws in the Saginaw Valley, U.S.A.," by Mr. L. H. Ransome.

May 17.—Paper read, "On the Manufacture of Salt, near Middlesbrough," by Sir Lowthian Bell.

May 24.—Paper read, "Accidents in Mines," by Sir Frederick Abel.

STUDENTS' MEETINGS.

April 29.—Paper read, "Flour Mills and their Machinery," by Mr. A. Chatterton.

### INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

May 4th.—Paper read, "On the Manufacture of Portland Cement in Dublin," by Mr. A. G. Ryder.

### ROYAL METEOROLOGICAL SOCIETY.

May 18.—Papers read, "Brocken Spectres and the Bows that often accompany them," by Mr. H. Sharpe; "Results of Thermometrical Observations made at 4 ft., 170 ft., and 260 ft. above ground at Boston, Lincolnshire, 1882-86," by Mr. W. Marriott; "Snow Storm of March 14th and 15th, 1887, at Shirenewton Hall, near Chepstow," by Mr. E. J. Lowe.

### SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

April 28th and May 12th.—Papers read, "Measuring the Coefficients of Self and of Mutual Induction," by Professors W. E. Ayrton and J. Perry.

### GEOLOGICAL SOCIETY.

April 27.—Papers read, "The London Clay and Bagshot Beds of Aldershot," by Mr. H. G. Lyons; "Supplementary Note on the Walton Common Section," by Mr. Hudleston.

May 11.—"The Rocks of Essex Drift," by Rev. A. W. Rowe; "The Remains of Fishes from the Keuper of Warwick and Nottingham," with Notes on their Mode of Occurence, by Rev. P. B. Brodie and Mr. E. Wilson.

### ROYAL STATISTICAL SOCIETY.

May 17.—Paper read, "The Inhabitants of the Tower Hamlets (School Board Division), their Condition and Occupations," by Mr. C. Booth.

### ROYAL MICROSCOPICAL SOCIETY.

May 11.—Paper read, "On the different Tissues found in the Muscle of a Mummy," by Dr. Maddox.

### SOCIETY OF CHEMICAL INDUSTRY.

May 2.—Paper read, "Recent Bacteriological Research in connection with Water Supply," by Dr. P. F. Frankland.

### THE MINERALOGICAL SOCIETY.

May 10th.—Papers read, "Microscopical Studies on some Eruptive Rocks from the Caucasus and Armenia," by Dr. Hjalmar Gylling; "Note on some Specimens of Glaucophane Rock from the Isle de Groix," by Professor Bonney; "On the Crystalline Form of Kreatine," by Mr. L. Fletcher; "Note on Francolite," by Mr. F. Butler; "On the Meteoric Iron seen to fall in the district of Nejed, in Central Arabia, in the Spring of 1865," by Mr. L. Fletcher; "On a Granite containing Andalusite from the Cheesewring, Cornwall," by Mr. J. J. H. Teall. Professor J. W. Judd exhibited some specimens and sections of Tabasheer and other forms of Opal, and made some observations thereon.

### THE MINING ASSOCIATION AND INSTITUTE OF CORNWALL.

April 28.—Paper read, "The Softening and Purification of Water for Boiler and other purposes," by Mr. C. H. Fitzmaurice.

### INSTITUTION OF MECHANICAL ENGINEERS.

May 17.—Papers read, "On the Construction of Canadian Locomotives," by Mr. F. R. F. Brown; "Experiments on the Distribution of Heat in a Stationary Steam-Engine," by Major T. English; "On Irrigating Machinery on the Pacific Coast," by Mr. J. Richards.

### UNITED SERVICE INSTITUTE.

April 29—Paper read, "Accuracy of Artillery Fire," by Major G. Mackinlay.

May 11.—Paper read, "Coating Ships of War at Sea," by Lieut. C. Bell.

May 18.—Paper read, "The Interior Economy of a Large Fleet," by Commander Charles Campbell.

### VICTORIA INSTITUTE.

May 2.—Paper read, "The Rock Hewn Capital of Idumœa," by Professor Hall.

THE ROYAL INSTITUTION.—At the general monthly meeting, held on May 9th, 1887, the Right Hon. Earl Percy, Manager and Vice-President, in the chair, the following Vice-Presidents for the ensuing year were announced:—The Earl of Crawford and Balcarres, F.R.S., F.R.A.S.; Warren de la Rue, Esq., M.A., D.C.L., F.R.S.; William Huggins, Esq., D.C.L., LL.D., F.R.S.; The Right Hon. Earl Percy; Sir Frederick Pollock, Bart., M.A.; Edward Woods, Esq., Pres. Inst. C.E.; Henry Pollock, Esq., Treasurer; Sir Frederick Bramwell, D.C.L., F.R.S., M. Inst. C.E., Hon. Secretary. John Tyndall, Esq., D.C.L., LL.D., F.R.S., was elected Honorary Professor of Natural Philosophy, and the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., was elected Professor of Natural Philosophy.

INSTITUTION OF MECHANICAL ENGINEERS.—The summer meeting of this Institution will be held in Edinburgh, and will commence on Tuesday, the 2nd of August. For organising the arrangements of the meeting an influential local committee has been formed, of which the Marquess of Tweeddale is Chairman; and St. John V. Day, Esq., C.E., F.R.S.E., has undertaken to act as Honorary Local Secretary. A similar committee in Dundee has also been formed, of which Provost Ballingall is Chairman; and Professor Ewing, B.Sc., F.R.S.E., has kindly undertaken the duties of Honorary Local Secretary.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

5271.—JAMES DOUGLAS DALLAS, 10, Trevor Terrace, Rutland Gate, London. "Electrical type-setter." 12th April, 1887.

5274.—R. RENDELL. A communication from Ansel B. Jones, United States. "Electric clock." 12th April, 1887.

5294.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Theodore Yates, United States. "Breech-loading ordnance." (Complete specification.) 12th April, 1887.

5299.—GEORGE VALIANT and JOSIAH NESBITT, 323, High Holborn, London. "Stamping and embossing machines." (Complete specification.) 12th April, 1887.

5303.—HENRY WILLOCK RAVENSHAW, WALTER THOMAS GOOLDEN, and ALEXANDER PELHAM TROTTER, 23, Andalus Road, Clapham, London. "Dynamo-electric machines." 12th April, 1887.

5307.—JAMES THOMAS BOSTOCK IVES, Toronto, Ontario. "Illustrating geological stratification and the attendant phenomena." 12th April, 1887.

5308.—SAMUEL HERBERT FRY, Fairfield Villa, Kingston-on-Thames. "Giving rigidity to flexible photographic films." 12th April, 1887.

5361.—THOMAS HENRY SIMMONDS, 57, Chancery Lane, London. "Microscopic slide-holders." 13th April, 1887.

5379.—JOHN ROBERT ALSING, 9 and 10, Southampton Buildings, London. "Triturating cylinders." 13th April, 1887.

5433.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. "Manufacture or treating of cotton-seed oil and other products from cotton-seed, cotton-seed oil, or its residues." 14th April, 1887.

5493.—ROBERT WILLIAM ANDERSON, 177, Upper Parliament Street, Liverpool. "Type-writers." 15th April, 1887.

5504.—AMOS LEFEVRE KEEPORT, 77, Chancery Lane, London. "Obtaining the oxides, etc., of metals from their ores or from crude minerals." (Complete specification.) 15th April, 1887.

5305.—HENRY WILLOCK RAVENSHAW, WALTER THOMAS GOOLDEN, and ALEXANDER PELHAM TROTTER, 23, Andulas Road, Clapham, London. "Dynamo-electric machines." 15th April, 1887.

5509.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Paul Jacques Victor Létang, France. "Electric arc-lamps." (Complete specification.) 15th April, 1887.

5534.—ALBERT L. PARCELLE, 24, Southampton Buildings, London. "Electrical synchronous movements." (Complete specification.) 15th April, 1887.

5537.—HARRY JULIUS MACLURE and ROBERT DAVY BOWMAN, 24, Southampton Buildings, London. "Telephones." 15th April, 1887.

5562.—WILLIAM MAXWELL, 34, Claybrook Road, Fulham, S.W. "Generating, reproducing, and distributing electricity." 16th April, 1887.

5707.—EDWARD FREDERICK HERMANN, HEINRICH LAUCKERT, and HENRY WALTER KINGSTON, 28, Southampton Buildings, London. "Automatic cut-outs for electric arc-lamps, worked in series." 19th April, 1887.

5709.—ALPHONSE ISIDORE GRAVIER, 6, Breams Buildings, London. "Dynamo-electric machines." 19th April, 1887.

5712.—DAVID JOY, 47, Lincoln's Inn Fields, London, "Steam-engines." 19th April, 1887.

5714.—WILLIAM STEVENS SQUIRE, Clarendon House, St. John's Wood Park, London. "Manufacture of sulphuric anhydride." 19th April, 1887.

5720.—CARL COERPER, 45, Southampton Buildings, London. "Dynamo-electric machines." 19th April, 1887.

5743.—HENRY JOHN LAWSON, Coventry, Warwickshire. "Velocipedes for the better fitting them for war purposes." 20th April, 1887.

5775.—LEON SOULERIN, 47, Lincoln's Inn Fields, London. "Steam-engines." 20th April, 1887.

5786.—RICHARD MORRIS, 28, Southampton Buildings, London. "Magazines for firearms." 20th April, 1887.

5824.—JAMES WEST KNIGHTS and WILLIAM DENNISON GALL, 323, High Holborn, London. "Manufacture of carbolic acid and other tar acids." 21st April, 1887.

5831.—WILLIAM BENJAMIN BALL, 166, Fleet Street, London. "Stopping, weaving, or knitting machines." 21st April, 1887.

5840.—ALFRED VINCENT NEWTON. A communication from Alfred Nobel, France. "Projectiles." 21st April, 1887.

5845.—FREDERICK BROOKHOLDING JONES, St. Augustine's Chambers, College Green, Bristol. "Automatic tracheotomy tubes." 21st April, 1887.

5849.—JOHN DITCHFIELD, Ashton Road, Denton. "Method of filling wash boilers." 22nd April, 1887.

5855.—JOHN ALLAN, 6, Panmure Street, Dundee. "Weaving fabrics, with various colours of wefts, with two or more shuttles." 22nd April, 1887.

5862.—WILLIAM BLENHEIM, Englefield Green, Egham. "Driving of a number of clocks by magneto-electricity." 22nd April, 1887.

5920.—FRED SHAW and JAMES WILLIAM SENIOR, Commercial Street, Halifax. "'Jerrys,' or perpetual cutting machines." 23rd April, 1887.

5923.—GEORGE SALLNOW MARTIN, Birkbeck Institution, Breams Buildings, Chancery Lane, W.C. "Controlling the action of instantaneous photographic shutters with detent spring." 23rd April, 1887.

5951.—WILLIAM DENT PRIESTMAN and SAMUEL PRIESTMAN, 191, Fleet Street, London. "Motor engines operated by the combustion of liquid hydrocarbon." 23rd April, 1887.

6077.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from George W. Morse, United States. "Manipulating cartridges or cartridge shells for firearms." (Complete specification.) 26th April, 1887.

6082.—SOLOMON ANDREWS and FRANCIS EMILE ANDREWS, 6, Lord Street, Liverpool. "Camera obscura, for use in taking views and the like." 26th April, 1887.

6086.—SILVANUS PHILLIPS THOMPSON, 323, High Holborn, London. "Processes in electro-deposition." 26th April, 1887.

6087.—EDWIN DAVID WASSELL, 77, Chancery Lane, London. "Reducing the point in carbon in steel, and forming a homogeneous weld." (Complete specification.) 26th April, 1887.

6117.—GEORGE BELL WILLIAMSON, Wild's Hotel, Ludgate Hill, London. A communication from Houston Francis Logan, New Zealand. "Smelting crude antimony." 27th April, 1887.

6119.—JOHN BOUSFIELD, 59A, Micklegate, York. "Dating tickets at both ends with one compression, or stamp applicable to railway tickets." 27th April, 1887.

6135.—HOWARD FIELD, 4, Clayton Square, Liverpool. "Packing for steam and other engine and machine glands." 27th April, 1887.

6151.—FERDINAND BOSSHARDT, 8, Quality Court, London. A communication from Johann Rudolf Frikart, France. "Valve gear for steam-engines." (Complete specification.) 27th April, 1887.

6157.—THOMAS EDWARD HUSSEY, Northwold, Norfolk. "Armour-plating for vessels of war and other purposes." 27th April, 1887.

6165.—RICHARD SMITH CASSON, 55 and 56, Chancery Lane, London. "Manufacture of steel or ingot iron and phosphate of lime." 27th April, 1887.

6169.—PHILIPP TAFEL, 67, Strand, London. "Rolling mills." 27th April, 1887.

6172.—EDWARD DUNNING BARKER, 115, Cannon Street, London. "Grinding wheels." 27th April, 1887.

6173.—ROBERT ABBOTT HADFIELD, 33, Southampton Buildings, London. "Treatment of steel." 27th April, 1887.

6251.—HENRY SKERRETT, 6, Livery Street, Birmingham. A communication from Leon Fritz, France. "Machinery for cutting or making dovetails." 29th April, 1887.

6254.—GEORGE TOLSON, Commercial Street, Halifax. "Drying fabrics and fibres." 29th April, 1887.

6260.—JOHN BENNETT and JOSEPH BULTON, Brimscall, near Chorley. "Temple steps and apparatus thereto for looms used in weaving." 29th April, 1887.

6267.—ARTHUR CECIL COCKBURN and EUSTACE THOMAS, 26, Petherton Road, Canonbury, N. "Lock switches for use in electric circuits." 29th April, 1887.

6278.—GEORGE HOWARD HARRISON, 191, Fleet Street, London. "Steering screw steamers and other vessels." 29th April, 1887.

6295.—EDWARD KOHLER and MORRIS LACHMAN, 6, Breams Buildings, Chancery Lane, London. "Sewing machines." 29th April, 1887.

6300.—WALTER BETHELL, 20, High Holborn, London. "Packing employed for stuffing boxes of steam-engines, pumps, and the like." 29th April, 1887.

6314.—AMBROSE FLEMING, 4, St. Ann's Square, Manchester. "Signalling in foggy weather upon railways." 30th April, 1887.

6339.—ISIDRO PLOU, 67, Strand, London. "Preventing railway and other vehicles from leaving the rails." (Complete specification.) 30th April, 1887.

6354.—PAUL KIRCHOFF, 47, Lincoln's Inn Fields, London. "A rotary steam-engine or motor." (Complete specification.) 30th April, 1887.

# Scientific News

## FOR GENERAL READERS.

Vol. I.] July, 1887. [No. 5.

CONTENTS.



## CURRENT EVENTS.

Technical Instruction in Board Schools.—Sir Henry Roscoe, in conjunction with Sir Lyon Playfair, Mr. Dixon, Sir John Lubbock, and Sir Richard Temple, has introduced an important Bill in Parliament to provide for technical instruction in elementary day-schools. Under this Bill, any School Board, local authority, or managers of a public elementary school may provide day technical and commercial schools and classes for the purpose of giving instruction in any of the following subjects:—The several science subjects specified in the Directory of the Science and Art Department; the use of ordinary tools; commercial arithmetic and geography; book-keeping; French, German, and other foreign languages; freehand and machine drawing. Other subjects may from time to time be added, if sanctioned by the Committee of Council on Education, or by the Science and Art Department. To provide for these schools and classes, the power of School Boards, other local authorities, and school managers, is to be the same as that for providing elementary schools. They are also to have the power of providing or contributing to the maintenance of laboratories and workshops in endowed schools for the purpose of carrying on classes or instruction under the Bill.

These schools and classes are to be subject to the inspection of the officers of the Committee of Education, or of the Science and Art Department, and no scholar is to be admitted who has not passed the Sixth Standard, or some equivalent examination. The Committee on Education and the Science and Art Department are to have power to give grants, on such conditions as they may lay down, for any of the subjects taught; and School Boards or other local authorities are to have the power of raising loans to provide the schools and classes named in the Bill. For the purpose of obtaining these grants, a technical school or class is to mean a school or class carried on under minutes to be made by the Science and Art Department, and laid on the table of the House in the same way, and subject to the same conditions as the minutes regulating the educational grants of the Education Department. It will thus be seen that the aim of the Bill is of a far-reaching character, and if it is passed into law, it will doubtless give a great stimulus to the technical training of our handicraftsmen. It is true that the middle and lower-middle classes in this country are already overburdened with taxes, and at first sight they may think that they are not likely to benefit by affording their poorer brethren greater facilities for technical training. If, however, the question is viewed broadly, and if it is remembered that after all we have to seek the greatest good for the greatest number, it will be seen that directly and indirectly all classes of the community are interested in the improvement of our arts and manufactures. It is chiefly on these that we as a nation have to depend for existence, while at the same time foreign countries are pressing us hard, and show themselves to be keenly alive to the importance of giving their workmen and manufacturers the best possible technical instruction.

Gymnastics and Exercise.—We extract the following useful remarks from Dr. Angel Money's excellent book on "The Treatment of Disease in Children," just published. He says:—"Great is the good gymnastics may effect in many diseases; second only to exercise in the open air, it ranks high as a therapeutic agency. 'Try gymnastics' is very good advice; but the thing is how, when, where. The exercises must be adapted to each individual case. Every carefully and neatly performed muscular act is a gymnastic exercise; muscle is not alone acting, nerve centres and paths come in for the training. Blood and blood-vessel enjoy the education. Every action is attended by physiological nerve discharge and muscular contraction; each careful and neatly performed contraction means a definite co-ordinated nerve discharge. This is accompanied by an equally harmonious chemico-physical change in nerve and muscle. So the whole body benefits, for nerve, muscle, and circulation are actually, and excretion with assimilation indirectly, involved. The influence of habit is of immense importance; this applies everywhere in physiology and pathology. One disorderly movement is as bad as one orderly movement is good. A neatly and harmoniously performed mental or muscular act is a power for good; and conversely, clumsiness perpetuates itself."

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The Locomotive considered as a Hygrometer.—The correspondent of a contemporary makes a useful suggestion in connection with the steam given off from a railway locomotive. He points out that when the steam hovers about in the air as though uncertain whether to disappear or not, the air has nearly reached its point of saturation. If, on the other hand, the steam disappears rapidly, as though swallowed up in some way, it may be assumed that the air is dry, and that rain is improbable. His observations have extended over a considerable period of time, and he mentions that on a hot summer day he has seen a heavy passenger train going up an incline at full steam pressure, without any of the exhaust steam being visible. At other times the steam cloud is three or four yards long, sometimes as long as the train itself, and in very damp weather it extends far beyond the tail end of the train. He shows, in fact, that there is a direct relation between the visible length of the steam-cloud and the amount of moisture in the air, and he suggests that so simple and inexpensive a hygrometer should be used by farmers who live near railways.

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Technical Education in New South Wales.—We are very glad to see from the report of the Board of Technical Education of New South Wales that technical education in that important colony is not only receiving much attention, but that the actual progress made is most satisfactory. In 1878 Parliament voted £2,000 towards the establishment of a technical or working-men's college, in connection with the Sydney School of Arts, and during the next five years many students attended the classes opened for them. In 1883 the Government decided to establish a State system of technical education, and the above-named Board were appointed to give effect to the scheme. The course of instruction followed is similar to that adopted by the City and Guilds of London Institute, with the outlines of which our readers are already familiar. There are now fifty classes in active operation, and more still will doubtless be established, as endeavours are made to found a new class whenever there are twelve applicants for it, who are ready to pay the necessary fees. During the past year there were as many as 2,364 students.

Some of the work done by the students in the art sections has been sent to the Science and Art Department in London, for classification at the annual examination recently held, and we are pleased to know that prizes and certificates have been awarded to several of the Colonial competitors. It is also satisfactory to know that arrangements have been made with the City and Guilds of London Institute for the extension to New South Wales of their system of technological examinations. In this way Colonial students will undergo precisely the same examinations as the students in London, and all will be examined and classified by the examiners in London. One great benefit of this will be that all prizes and certificates will be awarded on a uniform basis; and it is also pleasant to think that this wholesome striving for awards of equal value in the two countries will be another bond of union between them. On principle we are not enamoured of State-managed departments, and prefer the independent action and adaptability of individual members of a community. At the same time, it is far better for the State to come forward with its material aid and active co-operation, rather than let time be wasted in seeking doubtful support from individuals. We therefore congratulate our colonial cousins on the steps which have been taken, and on the rapid and substantial progress which has been made in this very important movement.

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Life on the Ocean Wave.—The Biological Society recently gave a successful *soirée* at University College, Gower Street. In the Zoological Museum there was a really fine exhibition of preparations by Dr. Penrose of typical bacteria, and besides these there were many other objects of biological interest. The chief attraction, however, was Professor Moseley's lecture on "Life on the Ocean Surface." There was a fine display of excellent coloured diagrams, and although it was not possible on such an occasion for the lecturer to make more than superficial references to the many varieties of pelagic animals illustrated, no one present could have failed to be impressed with the structural beauty, and fitness for their special modes of life, of some of the specimens. In order to escape their enemies, some of these varieties are almost entirely transparent, and have the same blue tint as the sea water. On the other hand, one variety of fish carries above its head a little tail with a bunch of processes, which are phosphorescent. This head-light acts as a lure to the animals on which the fish preys, and as soon as they are within reach of his capacious mouth their doom is sealed.

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In his opening remarks, Professor Moseley mentioned that the term pelagic fauna is given to those animals who live on, or near the surface of the ocean. A few of them like to bask in the sunlight, and remain on the surface during the day; but most of them go lower down during the day, and only return to the surface at night. It is, however, supposed that they never go lower than twenty-five fathoms (150 feet), as sunlight does not penetrate to a greater depth. Not that light is essential to all the animals, as some of them have not even the means of seeing, but it is necessary for the growth of the algæ on which many of them feed. It is, moreover, supposed that those animals which sink and rise diurnally, do so in order to travel over a greater range of feeding ground, to find in fact fresh fields and pastures new. The carnivorous lion of the desert feeds on the herbivorous antelope, but the latter could not subsist, nor could the lion exist, unless there were herbage for its victim to feed on. In the same way there are carnivorous fishes, but the creatures they live on could not subsist without the algæ which afford them nourishment.

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Photographs of Lightning.—The Council of the Royal Meteorological Society are desirous of obtaining photographs of Flashes of Lightning, as they believe that a great deal of research on this subject can only be pursued by means of the camera. Our readers are, therefore, requested to give any assistance they can, either by sending copies of any photographs of flashes of lightning which they may already possess, or by endeavouring to procure some. It may perhaps be well to mention that the photography of lightning does not present any particular difficulties. If a rapid plate and an ordinary rapid doublet with full aperture be left uncovered at night during a thunderstorm for a short time, flashes of lightning will, after development, be found in some cases to have impressed themselves upon the plate. The only difficulty is the uncertainty whether any particular flash will happen to have been in the field of view. The thunderstorm season is now approaching, and doubtless many photographers will be found willing to take up this interesting branch of their art.

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The Protection of Trees against Insects.—Not only in this country, but in many others, the destructive effect of insects on trees has long been a matter of serious concern. This is especially the case in some of the leading cities of the United States, where it is no uncommon event for a large tree to be completely denuded of foliage in the course of a season. So serious, in fact, has the matter become, that the Government officials have taken it up, and Professor C. V. Riley, the chief of the Bureau of Entomology, has for some time given very close attention to it. We learn from the *Scientific American* that in the first instance he was led to examine the condition of the trees in the park and grounds of the Capitol at Washington, and this brought forcibly before him the fact that a problem of much importance had to be dealt with, because the trees in many other places were exposed to similar influences. The results of these inquiries are embodied in a pamphlet issued by the United States Department of Agriculture, and its perusal will well repay all who are interested in the subject. It appears that when the English sparrow was imported, it was hoped that the destruction of many of the tree insects would begin, but the most injurious insects have not been attacked. It is rather feared that the sparrow has favoured the increase of these insects by driving away the native birds who used to feed on them.

Many plans have been tried for protecting the trees from insects; sometimes lime has been placed round the roots; sometimes the trunk has been scraped and whitewashed; or troughs filled with tar, or tarred ropes have been placed round the trees. These methods have been only partially successful, but according to Professor Riley, trees can now be effectually rid of insects by syringing them with arsenic compounds suspended in water. White arsenic or Paris green may be used, but "London purple," a residue from the manufacture of some of the coal-tar dyes, is recommended as less liable to burn the leaves. Moreover, owing to its colour, the trees which have been poisoned can then be distinguished from those not treated, and this is important. From one quarter to three-quarters of a pound is enough for forty gallons of water; the lesser quantity must not be exceeded for young and delicate trees. With this it is best to mix three quarts of cheap or damaged flour, as this makes the poison adhere and reduces the liability of the leaves to be burnt. Professor Riley recommends a good spraying nozzle mounted on a rod connected by a hose with a pump in the water barrel. Or if the process is to be carried out on a small scale, a pail and a hand syringe will be sufficient. During the operation, care must be taken to agitate the water to prevent the powder from settling to the bottom of the pail or barrel. It must not be overlooked, however, that the arsenic compounds are very poisonous, and great care must be taken to prevent any going on to the person of the operator, as arsenic is readily absorbed through the skin.

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The London School of Medicine for Women.—The annual distribution of prizes took place on the 14th June. We are pleased to find the Executive Council able to state, in their official report, that this most useful institution is progressing very satisfactorily. In fact, those who remember the up-hill work of establishing the school, and the hundred and one battles which had to be fought against real and fancied objections, find their most hopeful expectations more than realised. During the past winter session twenty-two new students entered for medical study, and there is now a total of no less than sixty-six attending the school. Many of the past and present students have taken distinguished honours in the London University and other examinations, and Mrs. Garrett-Anderson, in her address as Dean of the School, emphasized the fact that the Council have taken the greatest care to insure the best conceivable instruction, scientific and practical, being given to those under their care. To say the least, it would be impolitic for them to do otherwise, but it would be unjust to suppose that this alone is their guiding principle: indeed we know that it is not so. There are now fifty-two ladies on the Medical Register, and as there is no lack of students to follow in their steps, we may assume that there will be no want of members for this new branch of the profession. Let them do good work and true, and their success will be assured.

## GENERAL NOTES.

Electric Lights for Pearl Fishing.—Electric lamps are now used by the pearl fishers. The light is projected into the water, and aid thus given to the diver.

Electric Lighting for Government Buildings.—We learn that the Treasury Department at Washington is gradually adopting the electric light for the buildings under its control.

Natural Gas.—The largest gas well in the world has been discovered at Fairmount, near Muncie, Indiana. The test of Professor Orton, State geologist of Ohio, shows that gas is flowing at the rate of nearly twelve million cubic feet per day.

A New Adulteration of Butter.—A new and certainly ingenious adulteration of butter has been invented. By adding gelatine, which absorbs ten times its weight of water, the consistency of the butter is retained, and the water adulteration is not noticeable.

Competition for a Prize Essay.—The Paris Society of Civil Engineers offers a prize of 3,000 francs for the best *éloge* of Henry Giffard, the well-known aëronaut, and inventor of the injector. This competition is open to foreigners, but the papers must be written in French.

Carbonic Acid as an Anæsthetic.—Carbonic acid, produced by the action of vinegar on marble, is supposed to have been used as an anæsthetic by the ancient Egyptians and Greeks. M. Ch. Ozanam reports to the Paris Biological Society, that anæsthesia induced by carbonic acid is very complete, may last a long time, and is without danger.

A Ventilating Window.—A German engineer named Henkels has invented a ventilating window pane, which admits fresh air while preventing a draught. Each square metre of glass contains 5,000 holes, which are of conical shape, widening toward the inside. The new device has already been adopted by some of the German hospitals.

Why Sun-light deadens a Fire.—The reason why "the sun puts out a fire" is thus explained: At the time of day when the sun shines into a room the fire is often allowed to get dull, and the sun's rays warm and rarefy the air in the room as much as the fire warms the air passing over it up the chimney. Hence the draught ceases and the fire goes out. To remedy the inconvenience open the door or the window, to let the warm air out and the cold in.

A New Telegraphists' Ailment.—A correspondent of the *Engineer* mentions that two telegraph operators, a male and a female, both otherwise healthy subjects, are being treated in Berlin for a newly-developed ailment, namely, the dropping off, one after another, of the finger nails. Prof. Mendel attributes this curious affection to the constant jar caused by the hammering and pushing with the finger ends, in working the Morse system of telegraphy.

Condensing Smoke by Electricity.—Last year Herr Pichler and Major von Obermeyer gave to the Vienna Academy an account of their experiments in condensing the smoke of furnaces by the electric method devised in this country by Professor Oliver J. Lodge and Mr. Walker. The electrical machine used proved to be of insufficient power; but Messrs. Siemens and Halske are now preparing a very large induction machine, with which the experiments will be continued.

The Wearing of Niagara Falls.—According to Professor Woodward, of Washington, the rock over which the falls flow, at Niagara, will be all worn away in about 2,200 years. The area of the rock worn away at the Horseshoe Falls, between the years 1842 and 1875, was 18,500 square feet, and between 1875 and 1886, 60,000 square feet. The length of the contour of the falls is 2,300 ft., and the time required to recede one mile, if the rate is 2·4 ft. per year, is 2,200 years.

Vulcabeston.—A new article, composed mainly of asbestos and india rubber, termed vulcabeston, forms a substance of the toughness of horn, although it can be made of any degree of flexibility. It is said to be a non-conductor of electricity, and to stand the severest test of acids, steam, gases, etc. It is also a bad conductor of heat, which has been so long known as the characteristic feature of asbestos, and it has been adopted by the United States Government for covering steam boilers.

Testing the Quality of Leather.—With machine-belts in particular it is desirable to have a proof of the good condition of the leather, and for this purpose, the following simple test is recommended in the *Revue Industrielle*. A small piece of the leather is placed in vinegar, and should the leather be perfectly tanned, the colour merely becomes somewhat darker; but when the leather is not thoroughly impregnated with tannine, the fibres are in a short time much swollen, and gradually the leather is changed into a gelatinous mass.

Luminous Paint in Theatres.—The Government Inspector of the Royal Bavarian Court Theatre (Herr Stehle) thinks the use of luminous paint is a great safeguard against panic in theatres, and he has had notices in luminous paint put up in the passages of that theatre to indicate the "way out." We understand that experiments are to be made at some of the principal London theatres with large-sized tablets, to ascertain if the rather poor light of the corridors is sufficient to excite the paint. It is believed to be sufficient, but, if necessary, the notices can be excited in a few minutes by a powerful lamp.

Overhead-Wires in New Orleans.—A new system of overhead-wires, introduced by Colonel Flad, is about to be adopted in New Orleans. The wires will be erected under the supervision of the Commissioner of Public Works, and the ordinary method of carrying them on poles will be abolished. In the new system tall towers will be erected at the corners of streets, and they will carry the wires over the roofs of the houses. There will be different classes of towers for the telegraph, telephone, and electric-light wires; and the wires will be run not less than 10 ft. above the roofs. An order has already been given for 224 towers.

To Prevent Mildew on Vines.—Professor Scribner, of the Department of Agriculture, Washington, in a paper on fungi, says that while the sulphates of copper and lime, applied separately, had very little if any effect in preventing mildew on vines, the combination of the two entirely prevented it. A good receipt is to dissolve one pound of sulphate of copper in two gallons of water; slake two pounds of good lime in the same quantity of water; and then mix the solutions, when the mixture will be ready for use. Another method is to dry the mixture of sulphates, and to blow the powder over the foliage.

Milk-Poisoning at Long Branch.—From *Health* we learn that the cause of the wholesale milk-poisoning at Long Branch has been discovered. It is said that it has been conclusively shown, for the first time, that milk warm from the cow, when placed in tight cans, undergoes a change, and that in the course of five hours it develops a poison called tyrotoxicon. Fortunately, it is customary among milkmen to cool the milk before sending it away, and it now appears that it is dangerous to deviate from this wise custom. A good precaution is to boil the milk before using it, as this dispels the tyrotoxicon and also destroys the germs of acid fermentation.

Wood Pulp for Furniture.—A writer in a Canadian paper, speaking of the possibilities of wood pulp as a substitute for lumber in the manufacture of furniture and other articles now exclusively made of wood, calls attention to the resources afforded by northern Canada for the best pulp-making woods. It is found that in some localities the forests are now at the best age for pulping purposes, and capable of yielding from forty to one hundred and twenty cords per acre, if the whole of the timber were utilised. By mixing the pulp with clays, asbestos, plumbago, mica, etc., substances of great closeness and with endless varieties of colour may be produced.

A Map of the Heavens.—The map of the heavens which the international astronomers, recently assembled at the Paris Observatory, are taking steps to prepare, will be composed of from 1,800 to 2,000 sheets, and will give an exact impression of all the groups of stars. A new impetus will thus be given to the science of astronomy, and it will be possible for astronomers to study the distribution of the stars, and perchance the constitution of the universe. Admiral Mouchez states that heavenly objects are now plainly visible, such as Maia, one of the Pleiades, which had hitherto escaped the observation of astronomers; and it is hoped that the same instruments will enable further progress to be realised.

Power for Electric Lighting from Niagara Falls.—A company in Buffalo has entered into a contract with the Niagara Falls Hydraulic Tunnel and Power Company to take 10,000 horse-power, at 15 dols. per horse-power per annum, for producing an electric current to light the city and serve various manufacturing purposes. The route for the proposed cable has been surveyed from Niagara Falls, a distance of 20 miles. Negotiations are also pending for lighting and supplying power to other towns in the vicinity. When Sir William Thomson and the late Sir William Siemens first suggested the use of the power so grievously wasted at Niagara, the public treated their statements as somewhat visionary, but in these days of rapid advance the realization of their hopes has not been long in coming.

A New Industry.—A new industry is being established in South Staffordshire in connection with the steel trade. A complete plant has just been laid down at the works of the Staffordshire Steel and Ingot Iron Company, Bilston, for the grinding of basic slag for agricultural fertilizing purposes. A slag-house, 140 ft. long by 50 ft., has been built for the accommodation of grinding machinery. The process is divided into three stages, the last of which completely pulverizes the slag, making it of such a fineness that it will pass through a mesh of 10,000 holes to the square inch. The slag, being composed of forty per cent. of lime and from fifteen to twenty per cent. of phosphoric acid, its value as an agricultural fertilizer is becoming increasingly appreciated.

Chemical Nomenclature.—The *Journal of the American Chemical Society* contains a report of the committee appointed to consider the questions of chemical nomenclature and notation. The subject is one of great importance, as it affects the only intelligible means which chemists have of expressing the reactions which occur. The report points to the necessity of a uniform practice being adopted by English speaking chemists, and recommends that, with a few minor modifications, the system of nomenclature originally adopted by the English Chemical Society should be adopted by American chemists. The committee warmly support Dr. Odling's suggestion for the introduction of simple empirical names for substances of complex structure and scientific name, especially in organic chemistry.

The Influence of Cold and Hot Baths.—From *Nature* we learn that M. E. Quinquaud has been investigating the influence of baths on respiration and nutrition. He finds, by experiments on dogs, that cold baths increase the consumption of oxygen, the consumption being on the average ten times more abundant after the bath than before. Very hot baths exert a like influence, but in a less marked manner. Cold baths (and hot as well, but in less degree) increase pulmonary ventilation; the quantity of air passed through the lungs is double or treble after the bath. At the same time a greater quantity of carbonic acid is expelled. By the analysis of arterial and venous blood, it is shown that the respiratory combustions are very much increased under the influence of cold or hot baths, and it is also shown that the production of blood sugar is greater.

A New Lift.—The great height of the tower proposed for the Paris Exhibition of 1889, has necessitated the invention of a lift, by which the whole ascent can be safely made in one journey. The plan to be adopted consists in having a vertical shaft with a spiral thread; and on the top of this there will be a cage in the usual way. On the ground level there is to be a truck or trolley of special construction, fitted to the shaft in such a way that, when the trolley is turned round, the shaft will be propelled upwards or downwards. The principle is, in fact, similar to that of an ordinary bolt and nut, in this case the shaft of the lift being the bolt, and the trolley the nut. The cage will be kept from revolving by fixed guides, so that the passengers will not feel the spiral motion of the trolley beneath it. The trolley is to be revolved by an electric motor or a water-engine.

Transmission of Articulate Speech.—M. Mercadier, in a memoir presented to the Paris Academy of Sciences by M. Cornu, contends that the transmission of articulate speech is chiefly, if not solely, the result of molecular motion in the plate of the telephone receiver. Vibrations of the plate as a whole are only capable of yielding a single tone and its harmonics. This tone remains unaltered when the plate is supported at various points which are nodal points for this particular note, but under these conditions the transmission of other tones is much enfeebled. An instrument so arranged M. Mercadier calls a mono-telephone. On the other hand, a diaphragm supported in such a manner as to be incapable of performing transversal vibration is still able to transmit speech with perfect clearness, although with considerable diminution of intensity.

Manganese-Steel Wire.—Professor W. F. Barrett, of Dublin, has been investigating the properties of some wire manufactured from steel containing twelve to fourteen per cent. of manganese. This wire has the peculiar property of softening when suddenly cooled, and hardening when cooled slowly. Its electrical resistance is very high, being nearly four times that of German silver, and about eight times that of ordinary iron. Hence Professor Barrett recommends it for electric lighting resistance coils. Manganese steel has very feeble magnetic properties, and therefore Professor Barrett thinks it would be serviceable for building the hulls of ships, since it would not affect the compass like other steel. In fact there are many uses for it. Its tenacity is great, and amounts to 110 tons per square inch of sectional area in the case of hard wire, and forty-eight tons in the case of soft wire.

Owens College, Manchester.—The library and the museum of Owens College have recently received valuable additions from the bequest of the late Mr. W. Walton, of Blackheath. Among the books are Reeve's "Conchologia Iconica," Sowerby's and Adam's works on shells, Sir John G. Dalyel's "Rare and Remarkable Animals of Scotland," and Nehemiah Grew's "Anatomy of Plants." The natural history specimens consist of about 7,000 species of shells and sixty glass models of invertebrate animals, which, together with the other collections in the college will make this section of the museum one of the most complete in the country. The museum has also recently been enriched by donations from several well-known Manchester gentlemen, of specimens from the great find of fossil hippopotami at Barrington, near Cambridge; and by the gift of the large fossil stigmaria found in the carboniferous rocks at Clayton.

Measuring the Bulk of Solids.—The following description of a simple apparatus for measuring the bulk of a small solid body, without immersing it in water, and without weighing it, is taken from the *Chronique Industrielle.* The instrument consists of a graduated glass tube, which is closed at one end with a rubber stopper, and at the other end with a metal cap, capable of being screwed on or off. The metal cap is made flat and broad, so that it can serve as a stand for the tube when in an upright position. Sand is put into the tube until it reaches the zero on the graduated scale, and the rubber stopper is inserted. The tube is then turned upside down, the metal cap is unscrewed, and the object to be measured is inserted. The cap is screwed on again, and the tube is replaced in its upright position. The level of the sand in the tube should then be noted, and the volume sought for will be seen on the graduated scale.

A Meteorite in Coal.—At a meeting of geologists at Bonn, Dr. Gurlt recently described a fossil meteorite found in a block of tertiary coal, and now in the Salzburg Museum. It had been examined by several specialists, who assigned different origins to it. After careful examination Dr. Gurlt had come to the conclusion that it was a meteorite. In form the mass is almost a cube, two opposite faces being rounded, and the four others being made smaller by these roundings. A deep incision runs all round the cube. The faces of the incision bear such characteristic traces of meteoric iron as to exclude the notion of the mass being the work of man. The iron is covered with a thin layer of oxide, it is as hard as steel, and contains, as is generally the case, besides carbon, a small quantity of nickel. It resembles the celebrated meteoric masses of Saint Catherine, in Brazil, and Braunau, in Bohemia, discovered in 1847, but it is much older and belongs to the tertiary period.

Growth of the Heart.—According to Dr. Benecke, of Marburg, the increase in the growth of the human heart is greatest and most rapid during the first and second years of life, its bulk at the end of the second year being exactly double what it was at birth; between the second and seventh years it is again almost doubled. A slower rate of growth then sets in, until about the fifteenth year, the augmentation of volume during the intervening seven or eight years being only about two-thirds. In the period of maturity which then approaches the growth of the heart again makes progress, the increase keeping pace with the advance toward maturity of the other portions of the system. After the fifteenth year, up to the fiftieth, the annual growth is about ·061 of a cubic inch, the increase ceasing with the fiftieth year, a slight diminution then ensuing. In childhood the male and female hearts are alike; after maturity the male heart develops more than the female, and the difference thus established is said to be maintained throughout the remainder of life.

Effect of Freezing on Bacteria.—Some important experiments have recently been made by Dr. T. Mitchell Prudden, of New York, on the effect of freezing on bacteria. In the case of *Bacillus prodigiosus*, there were 6,300 bacteria in a cubic centimetre of water before freezing; after being frozen 4 days, 2,970; after 37 days, 22; and none after 51 days. Of the *Staphylococcus pyogenes aureus*, there were a countless number before freezing; after 18 days of freezing, 224,598; after 54 days, 34,320; and after 66 days, 49,280. Of the *Typhoid-fever Bacillus*, the numbers were innumerable before freezing; 1,019,403 after being frozen 11 days; 336,457 after 27 days; 89,796 after 42 days; and 7,348 after 103 days. These results show that certain bacteria have a remarkable power of resisting the temperature at which water freezes; and Dr. Prudden recommends that the New York State Board of Health, or other authority, should have power to determine which, if any, of the sources of ice-supply are so situated as to imperil the health of persons consuming the ice.

Sensitiveness of the Sense of Smell.—From *Liebig's Annalen*, we learn that Drs. Fischer and Penzoldt have made a series of experiments upon the sensitiveness of the sense of smell. They used mercaptan and chlorphenol as their odoriferous substances and experimented in a room of 230 cubic metres capacity. A gramme of the substance was dissolved in a litre of alcohol; 5 c.c. of the solution were again diluted to a known volume, and from 1 to 3 c.c. of the latter solution were measured out into a flask from which a fine jet could be directed by the experimenter to all parts of the room, the air of which was subsequently agitated by the waving of a flag. At a given signal a second experimenter stepped into the room, and took his olfactory observation, which was checked by the independent observation of a third person. The result arrived at was that our olfactory nerves are capable of detecting the $\frac{1}{4600000}$ part of a milligramme of chlorophenol, and the $\frac{1}{460000000}$ part of a milligramme of mercaptan.

The Hydrophone.—From *La Lumière Electrique* we learn that Mr. A. Pares, of Altona, (Germany), has devised an extremely ingenious apparatus for detecting leakage in water mains. A rod, made of a substance that conducts sound well, is held in a vertical position by a tripod, and to its upper extremity is attached a metallic box containing a microphone. The apparatus is completed by a regenerative dry pile, a telephone receiver, and a pear-shaped contact-maker that permits of leaving the pile circuit open, and of closing it only at the moment of observation. On moving the rod over the water-pipe, any leak can be distinctly heard by the ear. It appears that the sensitiveness of the apparatus is such that the slightest leak in the pipes inside of a house can be ascertained from the street. When the observation is made in a place where there is much noise, it is well to use two telephone receivers, or, if but one be used, to close one ear by means of a small device which Mr. Pares calls an antiphone, and which forms one of the adjuncts of the apparatus. The microphone is so constructed that it can be fixed directly to a water pipe.

Salicylic Acid in Food.—The use of salicylic acid to prevent the fermentation of articles of food and drink especially susceptible to this change during storage or carriage has much increased of late years. Salicylic acid, however, and its salts tend to retard the action of the digestive fluids, and they have been supposed to act deleteriously on persons affected with weak digestion or renal troubles. In fact, the compounds have come to be viewed with gravest suspicion, and their use has been interdicted by many officials of boards of health. The French Government has recently had this matter carefully investigated through the Academy of Medicine. Their conclusions show that salicylic acid, in *small* doses, is probably harmless, but in larger quantities acts injuriously. As the acid is decomposed into other products it is practically impossible at present, by chemical methods, to determine the amounts actually added originally to the solution, and therefore to fix any definite limits for safety in using. It was therefore thought advisable to recommend total prohibition of the salicylic acid and its compounds for such purposes, even in small amounts.

Paper Bottles.—A process for making paper bottles has been invented by Mr. L. H. Thomas, of Chicago, and their manufacture is said to be becoming a considerable industry. The bottles are unbreakable, and of various shapes and sizes, and are produced much more cheaply than the ordinary bottles made of glass, stoneware, and tin. They are made by special machinery, and in their manufacture a large sheet of paper, glued and cemented on one side, is rolled on a mandrel into a tube of any required length, thickness, and diameter. An outer glazed covering, which consists of the coloured labels or inscriptions for the bottles, is then glued on the tube, which is afterwards cut up into the required lengths for a given number of bottles. The tops and bottoms, which in some cases are of wood and in others of paper, are then cemented in, and the necks of the bottles, where necks are required, are secured. The interiors of the bottles are then lined with a fluid composition, which sets hard and resists acids and spirits, and which makes the bottles suitable for containing ink, blacking, dyes, paints, and the numerous other substances now carried in glass, earthenware, and tin, bottles and cans. Irrespective of low cost, these bottles have the advantage of being unbreakable, and of not requiring any packing material in transit, while, the weight being greatly reduced as against that of ordinary bottles, there is a saving in the cost of freight.

Naturalists and Electric Light Experiments.—We learn from the *Electrical News* that the Liverpool Marine Biological Society recently chartered the steamer *Hyæna*, belonging to the Liverpool Salvage Association, and sailed for the Menai Straits upon an expedition of discovery and research. The *Hyæna* is supplied with dynamo machinery, and carries a powerful search-light at the masthead, as well as some submarine incandescent lamps, and the naturalists found much amusement during the evening in sweeping the Welsh coast with the powerful beam of the search-light. The submarine-lamps were lowered to a depth of 18 feet, and although the lamps themselves were lost to sight at less than half that depth, yet the surface of the water was lit up over a considerable area. Unfortunately the special object which the society had in view, namely, a study of the effect of the light upon the denizens of the deep, was not realized. This was explained by the fact that the strong tides which run through the Menai Straits sweep the fishes along with them, so that, however greatly their curiosity might have been aroused by the unfamiliar glare, they had no opportunity of gratifying it. This was, doubtless, as disappointing to the naturalists as to the fishes, but we cannot see that the latter were to blame. The naturalists ought certainly to have considered the effect of the tidal currents in drawing up the programme of their cruise. It is to be hoped they will obtain better results on their next expedition.

Salt in Frozen Sea-water.—One of the prettiest conceits in the world is that which deals with the power of the Frost King to eliminate all uncleanness from his crystal rocks, and to make pure sweet ice even from the salt waters of the ocean, or from the foulest swamp that ever existed. This story has been used to point many a moral and adorn countless tales, but we have seemed to be in danger of losing it of late years through the investigations of scientific men, who are popularly supposed to care not a fig for poetry or for romance. The idea that salt water forms fresh ice was doubtless first discovered by sailors, who found that the icebergs in the ocean were made of fresh ice. When icebergs two miles long and two miles broad were met with at sea, there was an ample supply of fresh water to be had for the trouble of breaking up the ice. It was soon discovered, however, that these vast ice masses were broken off from the ice sheets which covered Arctic lands, and were not born in the sea at all, but were products of the distant hills and mountains of colder climates. People found that a tub of dirty water left out in the yard overnight was covered with crystal ice in the morning, and it did seem as if the Frost King selected the clean parts of the water for his work. This has recently been denied, because salt-water ice has been found to contain salt, and many learned people say that in freezing, the frost only rejects about four-fifths of the salt which sea-water contains, and so it seemed that our beautiful story was to be relegated to the land of fables. The most recent investigations made by skilful students go to show that the contained salt in frozen sea-water is not part of the ice, but remains in the block as an unfreezable brine, over which the frost has no power. As all fresh water, even the purest, contains some foreign salts, it follows that no ice can be perfectly solid, while salt-water ice will be least solid of all. The experiments made on this subject have been very exhaustive, and are deeply interesting, involving many questions of interest to students, especially in regard to the movement of glaciers, which was once accounted for by the plasticity of the ice, but is now known to be due to the melting and freezing of the mass, or what is known as regelation. What will concern most people in connection with these investigations, however, is the fact that the pleasant old story about pure ice from foul water is not all a myth.—*Liverpool Mercury*.

Natural Gas in the United States.—We learn from *Iron* that a great scheme for the distribution of natural gas, by taking it from Pennsylvania and other districts to Chicago and other cities, is in contemplation in the United States. The undertaking is being promoted by the Illinois and Pennsylvania Natural Gas and Tube Line Company, which is said to have acquired the right of way for their pipe lines through Illinois, Indiana, Ohio, and Pennsylvania, and has already purchased 27,000 acres of natural gas territory in Pennsylvania. As a beginning, two parallel lines of piping from the gasfields will be laid to Chicago. A number of gasholders, capable of storing a very large supply of gas, will be constructed at the gasfields, and others for distribution and storage purposes will be erected along the line. One will probably be erected at Alliance, and another at Marion, Ohio; one at Richmond, Shelby, and Lima, and several at Fort Wayne. Fort Wayne will be a general distribution point, from which many large towns in Indiana will be supplied. Another distribution point will probably be located in Ohio for large towns in that state. Within a few miles of Chicago is to be another series of storage holders for that city, as well as several towns in Illinois, Wisconsin, and even in Iowa. The company expects to carry from the gasfields a million cubic feet of gas a minute. The Pennsylvania supply could be augmented by connection made with the gasfields of Ohio and Indiana en route. The scheme seems to be of such a stupendous character as to invite disbelief in its success or even its existence, but it is stated that the men at the head of the enterprise are persons of reliability, and that they seriously intend to give effect to the project. If the work is carried out, it will doubtless be of great advantage to western manufacturers of the Union, who would then obtain gaseous fuel at a cheap rate, and be able to compete with the manufacturers in localities more favoured by nature.

## DOMESTIC SANITATION.

No. 3.—Situation.

MANY of us have but a very limited power of selecting the spot where we are to live. We cannot set up our household gods at Bournemouth or Torquay, at Lyndhurst or Conistone, but we find ourselves, in virtue of the "struggle for existence," chained down in great, smoky cities. Yet even in these cities there is a choice of healthy and unhealthy districts—the latter sometimes the more fashionable.

Many persons suppose that the first point is to make for the higher grounds, and especially for hill-sides where, it is supposed, all impurities will very readily flow away. But experience tells a different tale. We could mention towns in the north of England, where declivities, almost too steep for vehicles, have suffered far more from cholera, small-pox, fevers, etc., than even the bottoms of confined valleys.

Nor is this, after all, anything paradoxical. In the sewers along such hill-sides the liquids tend towards the lower grounds, whilst the sewer-gases accumulate towards the upper parts of the drains and there seek an exit.

If there is no regular system of sewerage the case is many times worse. The soakage from cesspools, as well as all other kinds of waste liquids, trickle gradually down from level to level, and find lodgments under the foundations of houses. A well-built city on a steep hill-side, has, indeed, a very picturesque appearance—

> "Line o'er line,
> Terrace o'er terrace, nearer still and nearer
> To the blue heavens.'

But it somewhat mars our enjoyment of such a scene if we reflect that each terrace thus becomes a kind of sewer for those situate higher up the declivity, and the ground is soddened with pollution. Far safer it will always prove to live on a well-drained plain with inclines just sufficient to prevent anything from accumulating in the sewers.

From questions of levels and altitudes we come next to that of the soil, or rather of the sub-soil. We commonly see houses or plots of building-land recommended as situate on the sand, the gravel, or the chalk. Now it is perfectly true that such sub-soils, from their dryness and consequent warmth, will be found most suitable for rheumatic subjects or for persons liable to affections of the chest, such as bronchitis, asthma, etc. But before a sandy or chalky soil can be pronounced preferable in all points to one of a heavier character we must have answers to some difficult questions. Has any putrescent organic matter soaked down into the soil from above, or drained into it from neighbouring higher grounds? This is not at all improbable if the plot in question has been used as a market-garden, and been of course saturated with animal manures. Should such putrescent matter exist below, the gases given off will rise up through the porous soil, carrying with them disease-germs. So fully is this risk now realised, that if any of our troops are on the march in unexplored tropical regions, they are caused in preference to encamp on clay soils where there is less fear of poisonous emanations.

It is, therefore, prudent to select a house built upon a compact sub-soil, if only well drained to get rid of damp, rather than one placed upon a light, porous stratum of whose history nothing is known.

The greatest danger to be avoided is one far too common in the outskirts of London, that is, so-called "made ground." It often happens that clay, where of a desirable quality for brick-making, is dug away to a considerable depth. A notice is then put up to the effect that "Rubbish may be shot here," which does not, however, authorise the summary execution of "Jerry" builders. The cavity is then gradually filled up with promiscuous rubbish, such as the contents of dust-bins, after everything of a saleable character has been picked out. Now, the dust-bin, unfortunately, is not the receptacle merely for ashes, fragments of crockery, and other inorganic refuse. It may, and often does, contain putrid fish, the stalks and parings of vegetables, and, in short, anything undesirable, which all the skill of a modern maid-servant cannot force down the sink. That such matter when left to accumulate must putrify and give off offensive odours, needs not to be demonstrated. Yet upon such masses of abomination, Jerry aforesaid will lay the foundations of a "desirable residence, replete with every modern convenience"—replete also, too often, with the seeds of disease and death.

It ought to be binding upon all corporations, parish or other local authorities, to pass all dust-bin refuse through one of those "destructor" furnaces which are now in use, before it is employed for mending roads, filling up hollows, or the like.

Among other enemies to well-being rank graveyards and cemeteries, especially when placed, as they too often have been, on elevated ground. Many persons remember, but many more have forgotten, the crusade carried on by Dr. George Walker—"Churchyard Walker," as he was then called—against the City graveyards, and generally against interment within and near churches, and close to human habitations. Like most pioneers, he was opposed, insulted, bullied, and when the great reform which he urged was finally accepted, the credit of the enterprise was given, and is still given, to others, who shine, if at all, mainly by the reflection of his light. But let this pass. In a couple of centuries we shall adorn the sepulchre of George Walker, the father of modern sanitary reform.

But the closing of the City graveyards only displaced, without destroying, the nuisance. The cemeteries which were laid out, as it was thought, at a safe distance from London, are now bordering upon, almost enclosed by populous, growing suburbs. Thus the caution is needful, "Keep away from the cemeteries." And this word of warning will be required until cremation, the "pure fire-angel," is universally adopted.

Other foci of mischief to which every prudent man will give a wide berth are the hospitals erected by the Asylums Board.

We now find ourselves approaching the sewage question, the disposal of the offensive but unavoidable refuse products of animal life.

On this subject the individual householder seems powerless, and can simply use the facilities provided for him by the community. But his vote and his influence go to decide whether a rational or a foolish system of sewage treatment is to be adopted. We will venture to add that until every ratepayer has a clear understanding of the question there is a strong probability that the local authorities will go astray.

The problem is two-fold. We must prevent these substances from polluting the air, the waters, and the soil, or from becoming in any way offensive or dangerous; and, secondly, we must restore them to their proper place, the cultivated land, so as to maintain its power of yielding crops. Whatever method of dealing with sewage fails to fulfil both phases of the question stands self-condemned.

It must be remembered, as it has been proved by numberless experiments, no less than by the experience of farmers and gardeners in all ages, that the entire mass of any soil is by no means food for plants. There are merely certain ingredients existing in limited proportions, which fulfil this function and which are capable of becoming exhausted. If we keep removing from any plot of land its vegetable produce, whether fruits, grain, roots, hay, or the like, and restore nothing, we render the land ultimately barren. Thousands of square miles of what were once luxuriant arable soils have been brought into this condition, and are now no longer worth cultivating.

To prevent the land from falling into this state there are only two methods. We must either import fertilizing matter from abroad to make up the loss; or we must restore to the soil the liquid and solid materials indirectly taken from it by all creatures which are being fed on the produce of such soil.

The former of these two methods sounds very plausible. But we must remember that in no part of the world do the elements of plant-food exist in unlimited quantities, and that the demand for them is constantly extending. Countries from which we used to import manures, such as bone ashes, dried blood, etc., are now themselves importers and are competing with us in the markets.

But leaving this on one side it certainly does seem somewhat absurd to pay money to foreign countries for fertilizing substances, and at the same time to be continually throwing similar fertilizing matter into the sea!

It is self-evident that the sewage of London, if properly applied to the land, would produce food enough to support the population of London, conditions of climate and weather being supposed fairly favourable.

Now, all this will doubtless be proclaimed mere truism, stale as the moral maxims in a copy-book. Granted; we have been uttering no sensational novelties, but old truths, which, stale as they have become, are perseveringly ignored.

We still hear proposals for doing almost anything with sewage rather than applying it to the land.

Most of us know that when cesspools were of necessity abolished in our towns, and the system of water-carriage introduced, each community poured the whole excrementitious matters of its population, as well as all other waste and polluted waters, domestic or industrial, into the nearest river. This was marvellously cheap, but, unfortunately, at the same time, supremely nasty. Not only was the entire manurial value of the fæcal matters wasted, but the river was rendered offensive to the senses and dangerous to public health. The water below the town became unfit for industrial purposes, deadly to fish, and hurtful, if not poisonous, to cattle. The next town down stream, though perfectly willing to contribute its quota to the pollution, conceived itself entitled to receive the stream in a clear and wholesome condition. Riparian proprietors complained that they were deprived of rights which they had enjoyed of old, and filed bills in Chancery to restrain the pollution.

To what an extent the character of our rivers has been altered by their conversion into common sewers may be gathered from the fact that within the memory of man, goodly salmon have been taken in the Clyde near the busiest part of Glasgow.

It must not be supposed that the claims of the riparian owners were always urged in favour of the purity of rivers. At a meeting for the discussion of this difficult question, we heard an elderly calico-printer, one of the most eminent in Britain, say, that when he began to experiment on the purification of his waste waters, he met with a totally unexpected rebuff. He received a letter from the solicitors to the ground-landlord informing him that the right to pollute the river was one of the easements of the estate, which might be lost if not continually exercised. By purifying his waste waters he was, therefore, it appears, breaking one of the conditions of his lease.

But where the pollution of a river was not a right established by old prescription it was frequently restrained by an injunction. And offending towns were in danger of having their sewer-mouths blocked up, and the sewage forced back upon them unless they took measures for its purification.

However, alike the Court of Chancery and the special Acts since past allowed the pollution of the Thames to continue, on the good old principle that on the large scale wrong becomes right.

*(To be continued.)*

## BASIC CINDER AS MANURE.

IN the Chemical Section of the Manchester Exhibition Professors Wrightson and Munro, of the College of Agriculture, Downton, near Salisbury, exhibit a chart showing the manurial value of Basic Cinder, and on a table are displayed samples of the cinder, ground and unground, precipitated phosphate of lime, and superphosphate of lime, both made from basic cinder, etc. The points of special interest with regard to basic cinder are (1) its manurial value owing to its highly phosphatic composition; (2) the extreme simplicity of its application as a fertiliser, all that is required being a disintegrator to reduce it to an impalpable powder similar to coprolite flour; (3) its abundance, one large steel factory (the North-Eastern Steel Company at Middlesborough) turning out 1,200 tons a week, or 62,400 tons per annum. This enormous quantity is all available for agricultural purposes, and may be regarded as a most timely assistance to agriculturists. Basic cinder should be applied freely, and at the rate of from half to one ton per acre.

The cost is at present too high, but doubtless this will adjust itself shortly to its true standard of value. The North-Eastern Steel Company are now erecting a powerful series of progressive disintegrators, and these will be in work during the present summer. The composition of basic cinder, analysed by Dr. Munro at Downton, is:

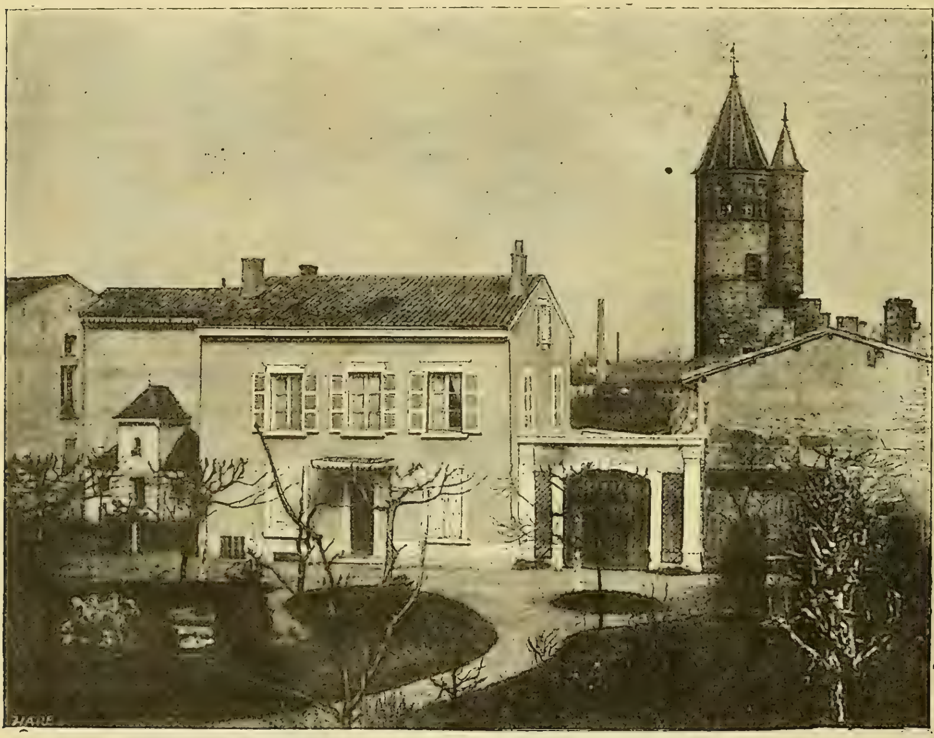
| | | |
|---|---|---|
| Lime .. .. .. .. | 41·54 | per cent. |
| Magnesia .. .. .. | 6·13 | " |
| Alumina .. .. .. | 2·60 | " |
| Protoxide of Iron .. .. | 14·66 | " |
| Peroxide of Iron .. .. | 8·64 | " |
| Protoxide of Manganese .. | 3·81 | " |
| Protoxide of Vanadium .. | ·29 | " |
| Silica .. .. .. .. | 7·40 | " |
| Phosphoric Acid .. .. | 14·30 | " |
| Sulphuric Anthydride .. | ·31 | " |
| Sulphur .. .. .. | ·23 | " |
| | 99·93 | |

In more recent makes the percentage of phosphoric acid has been three to four per cent. higher. Experiments made at Downton and at Ferryhill have demonstrated that the large amount of protoxide of iron, much of which is in combination with sulphur, has not acted injuriously on vegetation, and there appears to be no drawback whatever to the employment of very heavy dressings. Dr. Munro, in fact, submitted seeds to the most absolute test by actually germinating them in a soil composed of pure basic cinder.

BODIES TWO THOUSAND YEARS OLD.—The Smithsonian Institution has received from Col. J. H. Wood, of St. Paul, the bodies of five persons—a man, woman, and three children—taken from a cave in the Bad Lands of Dakota by a miner. The bodies are simply dried up, and are not petrified, but are in a remarkable state of preservation. Scientific men who have seen them say they belong to a race which probably existed two thousand years ago.

## PHOTOGRAPHY BY MOONLIGHT.

IT has been known for some time that photographs could be taken by moonlight, but it is only lately that really good examples have been produced. Moonlight is, of course, less powerful than sunlight, and, therefore, very sensitive plates must be used, and the exposure must be long. With these precautions it is, however, possible to obtain excellent results, and the original of the view taken at Lyons which we have endeavoured to reproduce is extremely good, many details being very clearly brought out if a glass is used.



FAC-SIMILE OF PHOTOGRAPH BY MOONLIGHT TAKEN BY MM. LUMIERE ET FILS AT LYONS.
TIME OF EXPOSURE, 3 HOURS.

This photograph was taken by MM. Lumière et Fils, of Lyons, who used one of their extra rapid blue plates; the exposure lasted three hours.

Our other illustration is copied from a photograph taken by Mr. James Jackson, the Secretary of the Geographical Society at Paris, who is a well-known amateur in photography, and who has kindly sent us several specimens of his work with moonlight and with gaslight. In this case also one of MM. Lumière's plates was used, and the exposure lasted one hour. During this long time the position of the moon changed considerably, and the comet-like streak of white on the photograph represents her path.

## FERMENTATION.—II.

IT is now ten years since the discoveries of Monsieur Pasteur were made known in translation * to the English people, and yet these ten years have produced comparatively small change in the system of manufacture. The old breweries and vinegar works go on with the same methods as have been in use for generations. Probably because M. Pasteur's recommendations to change were so revolutionary and costly, and the English mind rather tends to slow reformation than rapid revolution, our manufacturers have been content to try reforming past abuses rather than risk new methods. No reproach of want of progress, however, applies to our great scientists. Professor Huxley has analysed and measured the organisms of fermentation, watched their methods of multiplication and habits of life, and decided that they are vegetable and are allied to the large group of fungi. Professor Frankland brings forward arguments to prove by the rapidity of its multiplication, by the absorption of oxygen and giving off of carbon dioxide, that torula, or yeast, belongs to the animal kingdom, although to the lowest class of animal; and supplements this with

* "Studies on Fermentation;" translated by Faulkner and Robb.

the generally accepted theory that the line between vegetable and animal life is so extremely fine that its existence becomes doubtful. Professor Tyndall has shown us that not only yeast, but multitudes of other germs, are floating in the atmosphere (although to the naked eye the air seems quite clear), that this is especially the case in towns, and that the presence of these micro-organisms has no doubt given rise to the theory of spontaneous fermentation. He, moreover, shows the affinity between the comparatively large germs of fermentation and the many germs of human disease, research into which has since occupied Dr. Koch and other biologists, but this is too vast a subject for more than a passing allusion here.

Applying his theoretical knowledge, a brewer knows that the change which takes place in his fermenting vessels is the decomposition by a living organism of the maltose sugar, and the formation of alcohol and carbon dioxide, with a small quantity of subsidiary products of no value. He examines with his microscope the form and growth of the organism or yeast, and sees whether it is vigorous and budding, or shrunk and withered. Should the latter be the case, he knows it implies starvation, and that more food, or more oxygen, is required. Sometimes, however, the yeast cells are healthy, but are accompanied by germs of another form. If these are minute dots, either single or in pairs, forming the figure 8, he knows that they would set up a lactic fermentation; but if the foreign germs have the form of minute rods, sour beer would be the result, for these are the acetic germs of the vinegar maker. The chaplets of dotted germs denoting ropy fermentation, we hope do not enter modern breweries where cleanliness is studied.

It is easy to discern between some varieties of yeast, *e.g.*, the Saccharomyces cerivisiæ and the favourite S. Pastorianus of the Burton breweries.

The great difficulty is to get rid of these microscopical mischiefs. Monsieur Pasteur boldly suggests either that fermentation should be carried on at so low a temperature as to require tons of ice and miles of underground cellars, or that after fermentation had reached the necessary point, the beer should be heated. To the first of these, the cost of production is a fatal objection; to the second the loss of flavour by driving off the carbon dioxide is an insurmountable difficulty. Neither is it possible to filter the air on a large scale through cotton wool, or to carry on large manufactories in such pure mountain air, as that in which Dr. Tyndall tried his experiments. Antiseptics may, within limits, be used to advantage, but whatever is used to kill the smaller germs diminishes the vigour of the yeast.

We are thus thrown back, for practical purposes, on common-place customs. It has been known for generations by all good dairy women, that to keep the vessels sweet it is necessary to scald them with quite boiling water. Without knowing that lactic fermentation is the result of life, and that this life is destroyed at the temperature of boiling water, this practice has become firmly established. It is also known that boiled milk keeps longer than raw, that the scalded cream of the western counties is a more stable product than the raw cream of the other parts of England, and that the butter made from scalded cream also keeps sweet longer.

Copy of Photograph by Moonlight representing the path of the Moon during an exposure of one hour. Taken by Mr. James Jackson, Paris.

Following the same principle, brewers find that all fermenting and other vessels need constant and thorough cleansing with boiling water, and this cleanliness is a more formidable opponent to all disease in ferments than the most elaborate apparatus yet suggested.

But we must not forget, while acknowledging our debt to old customs, that they were the result of empirical observation, not of scientific principles. In the words of Professor Tyndall, "The brewer learnt from long experience the conditions, not the reasons, of success. . . . . It is the hidden enemies against which the physician and the brewer have hitherto contended, that recent researches are dragging into the light of day, thus preparing the way for their final extermination."

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Carbonic Acid in our Atmosphere.—It has been generally supposed that the percentage of carbonic acid in town and country air and in land and sea air would differ; but in experiments made by M. Blochmann, he has observed little difference, and, according to this gentleman, it really appears that vegetation, putrefaction, and the smoke of chimneys, have but a slight influence on the percentage of carbonic acid. There is, however, a little less in the air during daytime on land, and more in foggy weather and with a dull sky than with a clear sky and a fresh wind; stormy winds have their effects according to local peculiarities. M. Blochmann has been unable to determine any law with regard to the influence of rain. Violent volcanic eruptions, of course, affect the amount of carbonic acid materially.

## PHOTOGRAPHIC PAPER WITH GELATINE EMULSION.

IT is the gelatine dry plate that has made the art of photography so easy to practise, and has called so many thousands of amateurs into existence.

For many years past, practically all pictures from negatives have been printed on sensitized albumenized paper, *i.e.*, paper coated with white of egg, and made sensitive to daylight by means of a solution of nitrate of silver. At one time it was thought that nothing could supersede collodion, and in the same way albumen paper is now, or rather has been until recently, considered incapable of improvement. It is claimed, however, that through the medium of gelatine, a process has been discovered which bids fair to take the place held so long by albumen. There are already several kinds of these papers coated with sensitive gelatine emulsion, but we propose, in the present instance, confining our attention to that known as the "Alpha Paper," made by the Britannia Works Company at Ilford.

The old albumenized paper could be coated with albumen only a few feet at a time, but the alpha paper is made in a long roll, a thousand or more yards long, and two feet wide. From this roll the paper is passed on by elaborately worked-out machinery into the coating department, where it receives a coat of warm sensitive emulsion, evenly distributed. This is cooled so as to set it, and is afterwards hung up and allowed to dry. In this manner it is quite easy with the proper machinery to coat half a mile or more of paper at one time. When dry the paper is taken down and cut up to the various sizes required.

In order to use the alpha paper, it is placed behind the negative, and exposed either to gaslight or daylight, or even magnesium light; but as gelatine emulsion is incomparably more sensitive to light than the old sensitized albumen, a shorter exposure is necessary. For negatives of ordinary intensity an exposure may be required to diffused daylight of from one to twenty seconds, according to the season of the year, strength of light, etc. An exposure to gaslight of from half-a-minute to two minutes, according to the density of the negative, will generally be found correct. Daylight exposures generally give the best results; and one plan is to make the exposures in an ordinary room, about two feet from a window, not directly facing the sunlight, the time being about ten seconds, this depending of course on the negative and intensity of light. In this manner excellent results have been obtained, varying from a fine chocolate to a purple brown. With shorter exposures the tones become colder, while, if under exposed, black and white are the only tones obtained.

Some care is necessary in development; the print should retain a warmish tone at the time of washing off the developer, for if the operation be carried too far it will not be susceptible to proper toning. This, after treatment with the alum bath for the purpose of hardening, is the next operation.

If the print has been properly exposed and developed the toning bath adds a permanent warm tone. If exposure has been too long and development too short it becomes with increased toning more purple and even quite pink. The best tint, in our opinion—though taste varies in this respect—lies between the extremes, say a rich sepia or chocolate brown. This with a very little practice is easily attainable. The toning can be done by gaslight, or in subdued daylight, as in the case of ordinary albumen prints. With the above toning bath about three or four minutes will be found quite sufficient time to get excellent results. If the bath be diluted, of course longer toning becomes necessary, and this may often be desirable. After the toning comes the ordinary fixing bath of hyposulphite of soda. This latter behaves with the alpha paper in a somewhat peculiar way, differing from the ordinary albumen paper in that, with a longer soaking, the "hypo" acts as a second toning bath, and so much is this the case that if prints be insufficiently toned it helps matters considerably to allow them to remain for a longer period (say 15-20 minutes) than that necessary for the work of fixing, which is about four or five minutes.

The permanence of photographs on this paper is a point on which much stress is laid by its advocates. With gelatine silver paper there is no free silver, the whole of the metal being combined with a haloid body, and all the soluble salts washed out previous to coating. The paper will keep good for years before being used.

## A QUESTION IN PHYSICS.

SOME time since the following amusing problem was propounded by *La Nature*, and more recently has been reproduced by the *Journal de Physique Elémentaire*: When boiling coffee is poured into a cup, the drinker must wait till it cools. When sugar is added, it will of course slightly lower the temperature, but without taking into account the loss of heat by conduction, or the increase of volume due to the sugar, the question is whether it will be best to put in the sugar at once, or some time afterwards, in order that the coffee may cool as rapidly as possible?

The coffee will cool chiefly by radiation, and its rate of cooling will depend on the difference between its temperature and that of the bodies surrounding it. In other words, the hotter the coffee is, compared with the air, the more rapid will be its fall in temperature. This may be proved as follows:—

1. Let T be the initial temperature of the coffee. Then if the sugar be put in at once, the temperature will be $T - t$. After this, radiation will take place according to Newton's law, until the temperature has fallen to $\theta$, when the coffee is fit to drink. During a length of time, A, the temperature has fallen $T - t - \theta$ degrees.

2. On the other hand, suppose the coffee to cool down by itself to $\theta + t$, and then let the sugar be put in. It will of course bring down the temperature to $\theta$, and make the coffee fit to drink. Radiation in this case has again brought down the temperature the same number of degrees $T - t - \theta$, as in the first case, but the time in the second is shorter, and may be represented as $B < A$, for the temperature was higher both at the beginning and end of the period of radiation, and therefore, according to Newton's law, the rapidity of cooling was greater.

From this it follows that the cooling of the coffee will be more rapid if the sugar is added when the coffee is nearly ready to drink.

THE RESISTANCE OF SNOW TO A BULLET.—We learn from the *Scientific American*, that some interesting experiments were recently made at Ottawa, on the resistance offered by a bank of snow to the passage of a rifle bullet. It was found that Martini bullets, fired into a bank of well packed snow, were completely spent after traversing a distance of not more than four feet. In hard packed snow, mixed with ice, but not hard enough to prevent digging into it with an iron shovel, Snider bullets did not penetrate more than about four feet; in perfectly dry snow, packed by natural drift, but capable of being easily crushed in the hand, a bullet penetrated about four feet, and in loose drifted snow less than seven feet, though fired from points only twenty or thirty yards distant.

## THE SPECTRUM.—II.

If the light which Newton used in the important experiment, described on page 86, had consisted of a few separate colours, he would have seen as many round spots of differently-coloured light upon the screen. But there were innumerable colours, and they overlapped each other, forming a continuous band. Had one or two tints been missing, their absence would not have been noticed on account of this overlapping.

In 1802 the experiment was repeated by Dr. Wollaston, the eccentric physician who used a tailor's thimble for a galvanic battery, and a few watch-glasses in a tea-tray for a chemical laboratory, and who never permitted even his most

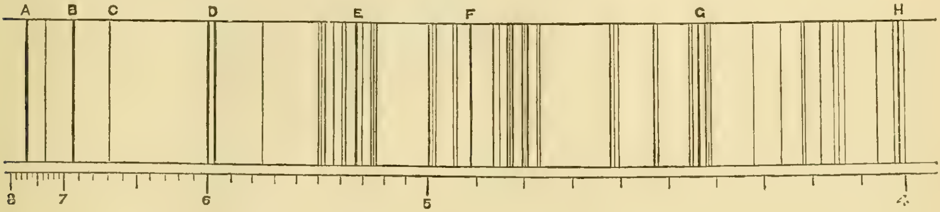


Fig. 4.

intimate friends to enter his study. Using a narrow hole or slit, he discovered that the coloured band, or spectrum, which had for 130 years been supposed to be continuous, was crossed by a multitude of fine lines. Some of the colours were, in fact, wanting, like missing skeins in a collection of threads of every hue.

It is somewhat surprising that Newton did not make this discovery, for he carried out a large number of experiments with prisms, and recognised the importance of a pure spectrum, and found that this could not be produced unless the prism was arranged at such an angle that the light passed through with a minimum deviation from its original path;

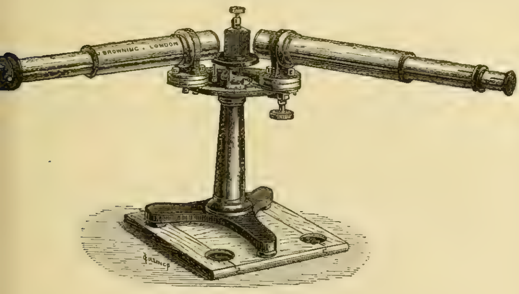

Fig. 5.

he found, too, that when this position was attained, the angle at which the ray struck the first face of the glass was equal to that at which it left the second face, and that, in fact, the minimum deviation can be arranged for only one part of the spectrum at a time.

We know that he tried holes of different sizes; he must have found that a large hole produced an impure spectrum, and that a smaller one gave a better, though fainter, result. He was probably nearer a great discovery, and missed it by less than did Captain Soutter, who grazed his immense flocks and herds on the Californian goldfields, and whose friend Marshall, in 1847, not only noticed the yellow grains in the mill-stream, but recognised their worth.

Wollaston saw the black lines, and was puzzled by them, but a German optician twelve years later examined the spectrum with great care, and mapped down 576 lines, which are called after him—Fraunhofer lines. He indicated the most prominent by the letters A, B, C, D, E, F, G, and H. The importance of his contribution to the work lies in his having pointed out that these dark lines are invariably present in the spectrum of sunlight, and in having shown, by accurate measurements, that they held invariable positions, the distance between any of them being always the same. He observed the spectrum of the moon and of Venus, and found the same lines present, the light being merely reflected sunlight. He found that ordinary flame gives a continuous spectrum free from dark lines. He therefore came to the conclusion that these dark lines, in whatever way they were produced, were due to some property of the sun, and had nothing to do with any imperfection in his instruments. He does not appear to have had any idea of their cause; he did not utilise them, as has since been done, for carrying out any discovery, but they will ever bear the name of Fraunhofer lines as a tribute to his accurate and patient work.

Fig. 4 represents some of the more prominent lines of the sun's spectrum. The scale shows the wave length. It will be noticed that the violet end is considerably extended compared with the red end, the spectrum represented being one produced by a prism. A diffraction spectrum from a grating would have had a uniform scale, the D line being almost exactly in the middle. The wave lengths are generally measured in millionths of a millimetre, for example the B line has a wave length of 686·7 millionths. Those who are not familiar with millimetres may form an idea of its size by noticing the thickness of a half-sovereign, and those who are not familiar with half-sovereigns may refer to the black line surrounding the advertisements on the cover of this journal, this line being about one millimetre wide.

With a powerful spectroscope the line A is found to be a broad band in deep red, forming the nucleus of a number of lines. B is a single line with two fainter ones very close to it. Between A and B is a cluster of lines indicated by one line only in Fig. 4. The spectrum is practically continuous up to C, a single distinct line. After a series of faint lines we come to the most remarkable of all, the D line; this is double, but needs a fine slit and a fair magnifying power to show it thus. The corresponding wave lengths are 589·5 and 588·9 millionths of a millimetre. It is in the yellow part of the spectrum. E is a group of fine lines in the green. A rather remarkable group a little further on has been named b. F is a strongly marked line in the blue. A number of small lines cross the spectrum after this, and cluster thickly not only in clear black lines, but in cloudy bands round G. The rest of the spectrum is very full of lines and dusky bands, and, lastly, in the violet, the lines H and $H_1$ are at the centre of two shaded stripes. The spectrum beyond this is very faint, and of a lavender colour; it can be made more visible by allowing it to fall on a screen prepared with a solution of quinine, or on a cell containing æsculin, a substance contained in the bark of horse-chestnut. The ultra-violet spectrum, as it is called, is then distinctly seen of a soft blue colour, and it is crossed by lines which have been described by the letters L, M, N, O, P, Q, R, and S.

It is necessary for the production of a good spectrum with straight lines that the rays of light falling on the prism should be parallel, not divergent. Fraunhofer, who made his observations with a telescope, placed the prism and telescope 24 ft. from the slit.

Mr. Sims introduced a simple method of obtaining parallel rays much more conveniently by placing a lens between the prism and the slit, and arranging the focus so that the rays falling on the prism are parallel. Such a lens is called a collimator.

Fig. 5* represents the simplest form of spectroscope, if the small pocket instruments be excepted. A pillar supports a graduated circle, in the middle of which is a turn-table carrying the prism. The slit is formed between a pair of knife edges, and its width may be adjusted by a screw. The slit is carried at one end of a tube, which is furnished with a collimating lens at the end facing the prism. A telescope magnifying eight to ten times, mounted on a moveable arm, can swing round the graduated circle, and its angular position may be determined by the scale and a vernier. The telescope not only magnifies the spectrum, but enables the eye to take in all the light falling on its object-glass, instead of only the small amount which could, be received by the pupil of the eye.

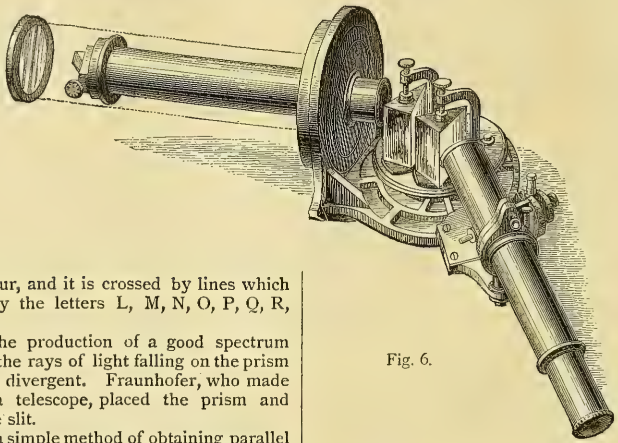

Fig. 6.

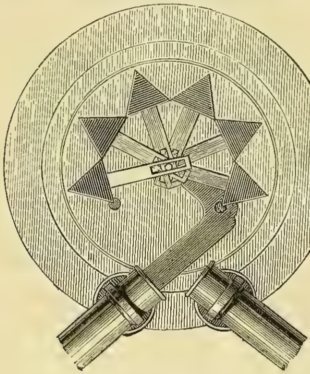

Fig. 7.

The prism is usually of flint glass, and has an angle of 60 degrees. In order to ensure that the collimator brings the rays parallel, the prism should be removed, and the telescope focussed on a distant object; that is to say focussed for practically parallel rays. It is then turned until it is in a line with the collimator, and this is then adjusted till the slit is seen distinctly. The prism is then replaced and may be set, together with the telescope, to the position of minimum deviation. A third tube is provided in more elaborate instruments, and carries a scale photographed on glass; the image of this is thrown by reflection from one side of the prism, up the telescope, in which it is seen together with the spectrum.

More than one prism is employed in most researches. The instrument illustrated in Fig. 6 is used for astronomical observations. It is provided with two prisms and a cylindrical lens instead of a slit. A star would give a spectrum of no appreciable width, but observed through the cylindrical lens it gives a bright line, which is observed as if it were the slit of an ordinary spectroscope.

In some researches very great dispersion is required, and to produce this a train of prisms is used; the light passing through each in succession is refracted more and more, and at the same time suffers more and more dispersion. It has been remarked that the necessary condition of minimum deviation must be observed in order to obtain a pure spectrum. With a single prism this can be easily arranged by the use of the turn-table, but with a train of prisms, each one has to be turned to the proper angle. Fig. 7 shows a train of prisms provided with a very ingenious means of giving the necessary twist to each prism. The prism on the left-hand side of the illustration is fixed to the circular table, and all the others are connected by hinges. A slotted plate attached to each prism is guided by a central pin which stands up from a bent lever. This lever is attached to the telescope, and the arrangement is such that when the telescope is moved to sweep along the spectrum from one end to the other, the prisms automatically place themselves so that at any moment they are in the position of minimum deviation.

* We are indebted to Mr. J. Browning for the illustrations of Figs. 5, 6, 7, and 8.

Fig. 8 represents a powerful spectroscope provided with this automatic arrangement. It is provided with four prisms and two half-prisms. The half-prism at the right hand is provided with two inclined faces, which reflect the rays back again, so that the dispersion is as great as though ten prisms were used. It will be noticed that the collimator, which is provided with an attachment for fixing it to a large telescope, is on a lower level than the observing telescope. The rays travel round the train of prisms in one direction, and are reflected upwards, and travel back again at a higher level.

*(To be continued.)*

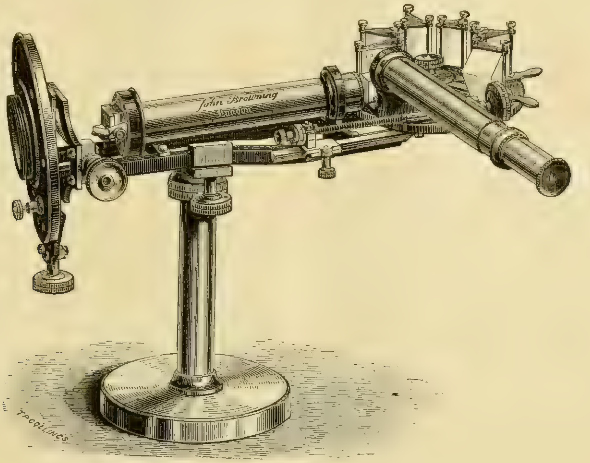


Fig. 8.

## DEVITALISED OXYGEN.

DR. B. W. RICHARDSON has recently made an observation which not merely places some novel and interesting problems before the chemist, the physicist, and the physiologist, but throws an important light on the question of ventilation.

It has long been known that animals confined in a limited volume of atmospheric air soon perish; just as, under similar circumstances, a burning candle goes out. This result has been hitherto ascribed simply to the progressive decrease in the proportion of oxygen, and the accompanying increase in that of carbonic acid, or, as it is now more generally called, carbon dioxide, as well as to the ammonia, watery vapour, and nondescript organic products thrown off from the skin and the lungs of the animals experimented upon.

The injurious effects of these gases and vapours Dr. Richardson by no means calls in question. But he points out a new source of danger in breathing air which has been already inhaled, hitherto quite overlooked. It has been put on record by some observers that pure oxygen acts as a stimulant, whilst other experimentalists found it to produce depressing, narcotic effects. How are such contradictory results to be explained and reconciled? It was naturally suggested that in the cases where depression and drowsiness were noted in the animals due care had not been taken to remove the carbonic acid produced by their respiration. But even where this was done, and done so thoroughly that the oxygen was found on chemical analysis perfectly pure, the same discordant effects were produced.

Dr. Richardson therefore modified the experiments; he placed the animals in a constant current of pure, freshly-prepared oxygen, kept at the temperature of 60° Fahrenheit. By this arrangement all impurities arising from the breath of the subjects were instantly swept away.

Differences were still perceived; some of the animals were thrown into a feverish condition, whilst others remained—for the time being at least—unaffected. But in none did drowsiness or depression set in, so long as the current of oxygen was kept up. Dr. Richardson was therefore fortunately led to try yet another manner of experimentation. He collected the oxygen as it issued from the chamber, and freed it from carbonic acid, watery vapour, ammonia, and all perceptible impurities, so that no chemical test was able to show any difference between its character and composition and those of freshly-made oxygen gas.

But when this charge of purified oxygen was passed for the second time through the chamber, a complete change ensued in the phenomena produced. All the animals became drowsy. The gas was repeatedly tested and found to be pure oxygen. The current was made more rapid, but the animals remained in a state of profound sleep, which ultimately ended in death.

Hence the conclusion was reached that oxygen which has been repeatedly passed through the lungs of warm-blooded animals, however thoroughly purified, no longer maintains life. Whether it has acquired some property not recognisable by chemical means, or whether it has lost some property which it ordinarily possesses as existing in the atmosphere, it has become "devitalised."

To prevent any misunderstanding we must here remind the reader that the air inhaled by no means loses the whole of its oxygen in its passage through the lungs. When breathed out again such air contains a decreased proportion of oxygen and an increased quantity of carbonic acid and other impurities. But up to the present day it has been taken for granted that such oxygen, if only collected and purified, would be again fit for maintaining life. It supports combustion as well as ordinary oxygen, and as far as Dr. Richardson's experiments have gone, it can be breathed by cold-blooded animals.

A further very curious fact is that such "devitalised" oxygen can be restored to its vital state by the electric action given off from a set of brushes connected with the positive pole of a frictional machine.

There is here evidently much yet to be learnt. But we may at any rate draw the practical conclusion that it is not merely needful for the air which we breathe to contain about twenty-one per cent. of oxygen. We see that such oxygen must not have been recently inhaled by men or other animals. We find ourselves on the way at least to attach a definite meaning to the term "stuffiness." We can understand why the air of the sea, the forests, and the mountains, should be felt as more refreshing and invigorating than that of towns. Lastly, we comprehend how a thunder-storm in common phraseology "clears the air."

Does the vitality of oxygen, perhaps, depend on a trace of ozone, too small to be detected by ordinary chemical methods, destroyed by passages through the lungs and re-created by electric action?

## CHEMICAL FIRE EXTINGUISHERS.

FOR some time past it has been a common practice in the United States to use glass hand-grenades, the contents of which are capable of extinguishing fires rapidly. Their introduction in this country is comparatively recent, but they are rapidly growing in favour, and are much to be recommended. The grenade is usually a glass flask containing about a pint of fluid, and several of these are hung up in places easy of access in the house, hotel, or other building to be protected. When a fire is detected, one or more of the


Fig. 1.

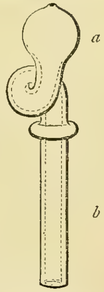


Fig. 2.

grenades are immediately thrown on it and broken, and the rapidity with which the fire is extinguished is very remarkable. What the liquid consists of is an open secret, but no satisfactory explanation has yet been given of the reason why it puts out flame so quickly. That it can do so is an undeniable fact, as we can testify from personal observation. The best grenade is that made by the Imperial Fire Extinguisher Co., and is shown in the accompanying illustrations, Fig. 1 being an elevation, and Fig. 2 an enlarged view of a special device which is in effect a self-acting relief valve for the escape of any gas which may be formed within the flask. The bulb (*a*) is pierced with a small hole at the top; the hollow stem (*b*) has a twist or curl, and in this a drop of liquid settles and forms a water seal at once sensitive and secure, and the straight part of the tube is fitted in the neck of the flask. By using this safety vent there is no need for the glass to be thick, so that the grenade can easily be broken when brought in contact with any hard substance at the critical time of fire.

## THE SALT INDUSTRY.

THE magnitude of the infinitely little has so many examples in nature that we cease from earliest childhood to marvel at the universal application of the law. Chalk cliffs, coral reefs, and other instances, are the favourite themes of juvenile wonder books; whilst our earliest memories of poesy are often associated with "the little drops of water, little grains of sand," adduced as examples for the infant moralist. If we wished to push the comparison further it might be stated that "these little drops of water" collectively hold in solution an amount of salt that would occupy 4,419,360 cubic miles of space; for such is the quantity supposed to be held in solution by the entire ocean of the world. This is equal to fourteen and a half times the bulk of all Europe above water.

To think that each time we sprinkle a taste of salt on our food we are helping to undermine a large tract of the British Isles is a sufficiently novel and surprising idea at the first blush; but such is undeniably the case. Within the last few weeks paragraphs have appeared in the daily papers with a heading "Subsidences in the Salt Districts," or some such title. We purpose in the present notice giving a few particulars of the way salt is procured, and the effect its abstraction from the earth has in the matter of these subsidences, basing our description on a visit recently paid to the chief salt-producing district of England. Before proceeding, however, to our more particular description, it will be well if we give a few general particulars on the subject.

Common salt, or sodium chloride, is divided industrially into two kinds, respectively bay salt or sea salt, and rock salt or mineral salt. The way that these are obtained for commercial purposes will be described later. That both kinds have a common origin in the ocean there is little doubt. The vast layers of rock salt, hundreds of feet below the surface of the earth, occupy a site that has in remote geological periods had the wide ocean rolling above it. The stratification of the beds of rock salt, interposed between layers of clay, marine shells, and various crystals that can only be formed in water, all point to this conclusion. At one time nearly all the salt used was obtained by the evaporation of sea water, and in some countries of much sunshine the industry is still largely carried on. In our own country, however, we have too little sunshine and the atmosphere is too humid to enable the more natural process to compete with the artificial methods we are about to describe. In Portugal over 250,000 tons of salt are obtained in this way from five works. Spain contributes 300,000 tons from the Bay of Cadiz, the Balearic Isles, etc. Italy makes 165,000 tons a year, and in France 250,000 to 300,000 tons are produced. The "Salzgärten" of Austria supply 70,000 to 100,000 tons annually. As compared with these figures, which are taken from the article "Salt" in the Encyclopædia Britannica, it may be noted that the Northwich salt district alone produced in 1881 1,600,000 tons of white salt and 166,740 tons of rock salt. The way in which the salt is obtained by natural evaporation is simple in the extreme, as indeed are all salt-producing operations. A tract of land near the sea coast is levelled and puddled, and this space is partitioned off by a chequer work of banks, the divisions thus formed being more and more shallow as they are placed further away from the portal where the sea water enters. The water flows from one division to another, the evaporating process going on all the time under the heat of the sun. At last the point is reached when the water is insufficient to hold the salt in solution, and it therefore appears in solid particles which are collected and stowed in heaps. The bitter salts, such as magnesium chloride, which exist in sea water along with sodium chloride, are allowed to drain away, they being fortunately more deliquescent. The flow of water is often assisted by pumping; and when a finer description of salt is required a further process of washing in fresh water and re-evaporation is gone through.

Bituminous deposits are often found in connection with salt, and, indeed, there seems some mysterious affinity between the two which has never been satisfactorily accounted for. Petroleum and brine seem to go hand in hand, and in China there are some brine springs in which the natural gas that accompanies them is used to supply heat for the evaporation.

There are many rock salt districts in Europe. The Transylvanian and Wallachian mines are very important, but the Wieliczka mine, in Galicia, is the best known, and has often been described. The bed of salt is said to be 500 miles long, twenty miles broad, and 1,200 feet thick. The length of chambers and galleries amount to thirty miles, and fifty-five thousand tons of salt are taken out yearly. As to other countries, the United States appear to be ill provided with salt, and British India is also lacking in this great essential to human existence. South America has brine springs, but does not work them. China and Siberia are well supplied, whilst Persia is said to be more richly endowed with salt than any other country in the world.

Having disposed of these general particulars relating to foreign salt, we will now proceed to deal with the district more particularly the subject of this notice.

The town of Northwich is the chief centre of the great salt-producing district of Cheshire. It has very much the general aspect of any other old-fashioned country town. Perhaps the first comment a stranger would make would be that the builders of the district must be of a particularly "jerry" order, and construct their houses without any foundation to speak of. Such a conclusion would be justifiable at first glance, but would be nevertheless a wrong to the builders of Northwich, for they must put in exceptionally sound work, otherwise their constructions would not stand brick on brick at all, as will be acknowledged by those who have the patience to read to the end.

Northwich, physically and economically, is founded on salt. Its inhabitants live, thrive, and have their being on salt. The river Weaver which flows through the town runs above salt, and carries little else but salt on its excellently preserved channel. All round the district there are engines at work, pumping up salt in the form of brine from beneath the thin crust, that it would be ridiculous to describe as the solid earth. When a Northwich householder finds his dwelling gradually settling into the nether depths he does not complain over much, knowing it is the common source of all his and his fellow-townsmen's prosperity that is lowering him a yard or two below his normal level.

There is little to describe in the manufacture of ordinary domestic salt, which is obtained from the brine; the rock-salt quarried from the mines in the manner to be presently described being used mostly for manufacturing purposes. Beneath the county of Cheshire there are vast deposits of the edible mineral; how vast no one knows, but they are to all appearance inexhaustible. A stream of water will break into one of these deposits, and if left alone would rise to the surface in the shape of a heavily-charged brine spring, or perchance find its way below to a river, or to the common source of all salt—the ocean. Such springs are, however, too valuable to be allowed to waste their riches in this way, or wander off to other districts, so bore-holes are sunk in all directions in order to intercept and bring them to the surface. When a successful prospector "strikes salt" he erects a pumping engine and draws up the brine. The liquor is run into large iron tanks, and by fires made under these the water is evaporated, leaving the salt to be drawn off, dried, and packed. Such is the mode of working in the present day, just as it was in this same district in the days of the Roman occupation of these Isles, excepting that the Romans had no steam-engines to bring the brine to the surface. The pans, however, want tending during the operation, otherwise the salt would settle and cause them to be burnt, because the water would not come in contact with their sides and bottom, and so carry off the heat. A given quantity of water will only hold a certain amount of salt in solution, and as soon as that amount is exceeded by reason of the evaporation, the salt forms in thin flakes on the surface, and has promptly to be drawn to the sides by men with long-handled rakes, otherwise it would sink to the bottom, and, as we have said, cause the pans to burn. The evaporating sheds of a salt works are a picturesque sight. The muscular figures of the operatives —and a man must have muscle for the heavy work at the evaporating pans, with but little clothing on—appearing and disappearing amongst the ascending clouds of vapour, and whisking off the flakes of salt with their long-handled implements, afford an effective picture, such as one seldom sees in any industry in these prosaic days of mechanism. When the wet salt is taken from the pans it is put into moulds and taken to stoves to be dried, and then we have salt fit for use.

All salt, however, is not used for domestic purposes, large quantities being employed in various processes of chemical manufacture. A good deal of this is got from salt mines, the "rock salt" thus produced being quarried below the surface, and brought up a shaft, much in the same way that other minerals are. At Marston, near Northwich, there is such a mine, which we lately had, through the kindness of the proprietors, an opportunity of visiting. The shaft of the Marston mine is 110 yards deep. The visitor stows himself away in the bottom of a capacious bucket, perhaps with one or two fellow-explorers, and an attendant stations himself straddlewise across the iron bow to which the chain is attached, in order to see that all goes right. Soon the winding engine begins to uncoil the length of wire rope, and the bucket falls rapidly through the three foot and a half diameter iron tube, which forms the lining of the shaft. At ordinary times the depths of a salt mine are of a stygian blackness, except where the candle of the miner may perhaps be tracing a zig-zag thread of light as he picks his way over the boulders of salt in the distance. So we found the Marston mine on our first arrival below; but the hospitable proprietors occasionally organize a grand illumination, and we had the good fortune to witness one of these displays. Under these conditions, a salt mine, generally so gloomy and dark, becomes a most charming spectacle. Points of light, arranged in symmetrical lines and curves, trace out the contour of the vast chambers and galleries, the walls of which are composed of the beautiful crystals of rock salt.

The main division of the mine is about eleven acres in extent, and twenty-six feet in height. The roof of this vast underground chamber is supported by massive columns, ten yards square, where the salt has been left for the purpose. These are placed twenty-three yards apart, and all between the rock salt has been hewn away. One hundred yards above on the surface of the earth runs a river and a railway, whilst the road of the district crosses, but no sound of the world above reaches through the solid crust of earth which forms the roof of the mine.

Within recent times compressed-air machines have been introduced for cutting the salt. On the surface above there is a powerful engine which compresses the air to a pressure of 70 lbs. to the square inch, and this compressed air is taken below through pipes to actuate the machines, just as steam is taken from a boiler to an engine. There is, however a very important difference between steam and compressed air for salt-mining purposes, for the exhaust steam from an engine would condense on the salt; and above everything it is necessary to keep a salt mine dry. On the other hand, the air escaping from the machines helps to ventilate the mine, and keep all fresh and sweet. The machines themselves are great horizontal wheels, which have steel teeth, or cutters, fixed to them. These are revolved by suitable mechanism, and so cut away the salt. A good deal of blasting is, however, done, and the dull explosions reverberating through the distant galleries do not a little towards adding to the strangeness of the scene.

Those remarkable sinkings of the earth's surface to which we have before referred, are not caused by salt-mining but by brine-pumping. When the rock salt is mined out it is necessary to provide in some way for the support of the roof, but the brine-pump sucks away impartially until a vast cavity is formed, and the earth sinks in to fill the hole. This naturally causes a depression on the surface, and some of these depressions are of remarkable extent. At Wilton, not far from Northwich, there is a large pond or lake, about eighty acres in extent, and in parts sixty feet deep. Not very long ago, where this water now is was dry ground, but the abstraction of salt from below has caused the earth to settle, and the water from the river Weaver flowing in has formed this large artificial, but unpremeditated pond. In cases of subsidence the earth does not appear to fall in with a rush, but there is a regular settlement, not rapid enough, we understand, to be perceptible in its movement, although the action quickly makes itself felt.

Sheets of water caused by such subsidences, locally known as "flashes," are not uncommon all down the course of the Weaver. They play a useful part in helping to keep the channel navigable, for in their still water much of the sediment held in suspension, and brought down in flood time, is deposited. In the neighbourhood of the Marston Mine there is a large basin or depression by the road-side. A few years ago this was high ground, but brine-pumping has caused the earth to settle so that the bottom of the subsidence is twenty to thirty feet below the ordinary level, which before was an unbroken flat. There is curious evidence of this in the broken track of a disused railway. In one part this railway runs along the normal level of the earth's surface. But on looking over the edge of the depression one can see the continuation of the line thirty feet below, just where it has been lowered by the falling of the earth.

In the town of Northwich the buildings lean all ways with most picturesque irregularity. A corner of a house may fall a foot or so, windows and doors originally orthodox and rectangular, become diamond-shaped, and the courses of brickwork show curves that may be graceful and might be pleasing enough in more appropriate situations. Then the energetic Northwich householder sets to work to keep his dwelling on the surface, either by "jacking up" and underfilling, or in some other way. Many of the houses are built on heavy beams of wood, and some are held together by complete systems of iron ties, struts, and braces. If matters are neglected, the householder may lose his dwelling altogether, and there is now one house in which the ground-floor has sunk so far that it has been necessary to cut a new front door between what were once the windows of the first floor bedroom. In other cases the bedrooms on the first floor have been conveniently transformed into shops on the street level. This is told of Winsford, a town close by, where a great deal of brine-pumping is carried on. Here the Town Hall had to be lifted eight feet in a couple of years, and the church has been raised seven times. Even Northwich Bridge itself, which spans the river Weaver, has the same downward tendency, and it is a part of the regular business of the river conservators to lift the arch bodily at intervals, so as to keep a sufficient height for the navigation.

Within the last year or so an effort has been made to establish a salt industry on the eastern side of England, at Middlesborough. The borings that have been made for the purpose of finding salt have attracted much attention, and success has been attained by going to considerable depths. In the Cheshire district, as we have seen, there are natural brine springs, and these have only to be brought to the surface, but in Middlesborough the overlying strata are of an impermeable nature, and water has to be taken down to the salt by tubes and pumped up again in the shape of brine, as was recently described by Sir Lowthian Bell at the Institution of Civil Engineers. The East-Coast salt industry is yet in its infancy, and to what extent it will develop remains to be seen.

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Sources of Platinum.—The most important sources of platinum are the mines at Nizhne-Taglsk and Forgo-Blagodat, in the Ural Mountains. About 80 per cent. of the world's production comes from this source. Next in importance are the gold washings of the Pinto, in the United States of Colombia. About 15 per cent. of the entire product comes from this source. It is also found in Brazil, Borneo, Hayti, Peru, India, Australia, and in the sands of the Chaudiere River in Quebec. It has recently been found in a quartz vein in New Zealand. Platinum has been found in small quantities in various parts of this country, associated with free gold in placer deposits, but it is only from the placers of California that it has been produced in a merchantable quantity, which amounts to between 100 and 200 ounces per annum, and is sold at 75 cents per troy ounce. It contains about 85 per cent. of the metal, and is shipped to London to be refined. The platinum used in this country comes almost entirely from Russia, and the imports amount to between 2,000 and 3,000 pounds annually.

Platinum "ore," as it is called, contains iridium, rhodium, gold, copper, and iron. It is sometimes, though seldom, found crystallized in cubes and octahedrons, but more usually in rounded or flattened grains, or "sand," having a metallic lustre. The importers' price for refined platinum has risen steadily since 1883, when it was 6 dols. 50 cents to 7 dols. 50 cents per ounce, according to the quantity bought. It is now worth 7 dols. 50 cents to 8 dols. 50 cents. The principal consumption is in the manufacture of chemical apparatus, but within the past few years the use of incandescent electric lights, and also gas jets made luminous by a heated platinum spiral, have caused an increased demand for the metal, and the steady rise in price during the past three years may be referred to this cause.—*Georgetown Courier.*

The Royal Society.—At the Annual Meeting of the Royal Society for the election of Fellows, held at the Society's rooms in Burlington House on Thursday last, the following gentlemen were elected:—John Young Buchanan, M.A., John Theodore Cash, M.D., Sir James Nicholas Douglass, M.I.C.E., Prof. James Alfred Ewing, B.Sc., Prof. George Forbes, M.A., William Richard Gowers, M.D., Prof. Alexander B. W. Kennedy, M.I.C.E., George King, M.B., Sir John Kirk, M.D., Prof. Oliver Joseph Lodge, D.Sc., Prof. John Milne, F.G.S., Rev. Octavius Pickard-Cambridge, M.A., George James Snelus, F.C.S., Thomas, Lord Walsingham, and William Whitaker, B.A.

DISINFECTION *v.* DEODORISATION.—It has often been pointed out in our columns, as elsewhere, that deodorisation is one thing and disinfection another. The destruction of bad smells by no means involves the destruction of "infective agencies," but the destruction of bad smells is also an important work, and one which every disinfectant intended for general use ought to accomplish. Carbolic acid is defective in this respect for, although a good disinfectant, it does not deodorise, and simply adds its own disagreeable smell to those which existed before. Chlorine, metallic chlorides—such as the chlorides of zinc, mercury, and lead—sulphurous acid, and the alkaline permanganates are far more effectual in this respect, and each possesses in a greater or less degree the power of disinfection. Whilst the "saucer" treatment of sick-rooms with a little Condy's fluid or chloride of lime may well be distrusted, the laudation of such means as the use of euchlorine (a mixture of chlorine and chlorine peroxide) and bromine as aërial disinfectants cannot be commended. Sulphurous acid is sometimes underrated. As gas it is just as unsuitable in the presence of patients as bromine or euchlorine, but in dilute solution it is very active. Complete disinfection of an infected atmosphere in the presence of patients is impossible, but partial disinfection is easy, and the complete disinfection of wearing apparel, bedding, etc., by the prolonged use of weak solutions of metallic chlorides, sulphurous acid, and the like, can be readily effected without the slightest injury to the fabrics.—*Lancet.*

PRICE-GIVING SCALES.—The *American Analyst* describes a very ingenious computing scale, the invention of Mr. L. A. Meneger, of Lansing, Kansas. The scale consists of a simple balance-arm resting on a nickel point, supported by a standard about eighteen inches high. There are two scales on the balance-arm. One denotes the weight and the total cost of the article weighed, the other the unit of price, which is designated by a sliding weight. From this sliding weight is suspended the scoop or slab to contain the article to be weighed. By this scale the total cost of any article to be weighed is given. For instance, if $7\frac{1}{2}$ pounds of butter be placed on the scale and the price be $13\frac{1}{2}$ cents a pound, the scale shows at once that the total cost is $1.01\frac{1}{4}$ dol. Or if a purchaser wishes 16 cents' worth of tea, the price of which is 75 cents a pound, the weight would be fixed, the sliding one at 75 cents, the other one at the 16 cents mark on the computing scale. Then, when enough tea should have been put into the scoop to cause the scale to balance, that quantity would be the 16 cents' worth desired.

IMPROVEMENTS IN TIN CANS.—An ingenious improvement in the manufacture of tin cans for preserving food is being introduced, the plan consisting simply in so forming the lid that it is merely pressed on and the can is hermetically sealed, so that no internal pressure can remove the lid. Water boiled in a tin thus closed has failed to force it off, although the steam pressure has burst the can itself. A penny piece, however, used as a lever by being placed under a rim formed around the top of the cover, with the shoulder of the can as a fulcrum, raises the lid with a remarkably small expenditure of power. The principle involved in the device is that of the wedge and lever. The neck of the tin on which the lid fits is formed at a very slight angle from the vertical, and the rim of the lid is made at a corresponding angle, no solder being used to form the joint. By means of this arrangement, therefore, the opening of cans is rendered a remarkably clean, quick, and simple operation, contrasting greatly in these respects with the inconvenient method of opening now in vogue.

FOREIGN AWARDS TO ENGLISH EXHIBITORS.—In these days of keen foreign competition it is refreshing to hear of foreign awards being made to English exhibitors. For this reason, and because of the excellence of their work, we congratulate Messrs. Hartley and Sugden, of Halifax, the well-known makers of horticultural and other hot-water boilers. They have just been awarded a Gold and Bronze Medal at the International Horticultural Exhibition held at Dresden, and in addition, the Russian Imperial Horticultural Society of Riga have voluntarily awarded them a special Silver Medal for the superiority of their horticultural boilers over all others exhibited.

## REVIEWS OF BOOKS.

*Chips from the Earth's Crust.* By John Gibson. London: T. Nelson and Sons. 1887.

The title of this book fairly well describes it. The "Chips" are pleasing to look upon, and may well attract attention to the mass from which they have been chiselled. Such papers not rarely carry the reader on to deeper researches into subjects which have for the first time been rendered interesting to him by the skilful, yet light-handed treatment of the author, who, indeed, can hardly desire for them a better fate. The article on Oil Wells strikes us as decidedly good, and that on Amber and Meerschaum treats practically and sensibly of substances which have always had about them a fascination, born possibly of the many old-world stories wherein they figure as something akin to the magical.

*The Steam Engine.* By George C. V. Holmes. London: Longmans and Co. 1887.

This is one of the "Text-books of Science" series, and is framed on the lines usually followed by the compilers of works of that collection. The author covers the ground necessary for the consideration of the subject as completely as can be done in the limits of space at his command. It will be evident, however, that in a small work of a single volume there must be much left unsaid when the steam-engine and boiler have to be considered theoretically and practically.

The scope of the book is set forth in the preface, wherein the author lays down four chief points he keeps in view, as follows:—

"1. The modern science of thermodynamics, which is the foundation of all knowledge of the steam-engine considered as an apparatus for converting heat into mechanical work.

"2. The effects exercised on the motion of quick-running engines by the inertia of their reciprocating parts.

"3. The geometrical methods of fixing the dimensions and the setting of slide valves.

"4. The investigation of the methods in use for diminishing the losses of efficiency in expansive engines, due to the cooling of the cylinders by the expanding steam; the principles of which methods are superheating, steam jacketing, and compounding."

In the consideration of these problems, the author travels over a very wide range of subjects. There is the usual introductory matter, describing the action of steam in the cylinder, the way in which it is admitted and allowed to escape by the slide valve, and other details of steam-engine mechanism. The fact of heat being a form of energy, Boyle's law, the heat of steam, and other matters of a like nature are explained; after which the theoretically perfect engine is considered. The mechanics of the steam-engine leads up to a chapter on the indicator, which is followed by others on fuel, its combustion, and the generation of steam. This is, of course, the boiler division of the book, and the various forms of boiler are illustrated and described. There is a chapter on condensers, and another on the principal causes of loss of efficiency: in fact, the book, as we have said, takes a wide range. The author begins with the most elementary aspect of the question and carries the reader forward until he finds himself amongst the higher mathematics, the calculus being often used, and there are many formulæ by no means simple in their construction. The work, however, is free from errors of a radical nature—at least, we have not been able to detect any lapses from recognised and accepted opinions.

*The Journal of Microscopy and Natural Science: Journal of the Postal Microscopical Society.* Published quarterly. Vol. vi. part 22. Edited by Alfred Allen. London: Bailliere, Tindall, and Cox; Bath: 1, Cambridge Place.

The Postal Microscopical Society is very well organised for promoting microscopical research, and for gradually developing the amateur into the observer and the investigator. Among the most important matter in this number is a very able paper by Mrs. Bodington on the "Evolution of the Eye." This lady points out one of the blundering flippancies of a late prominent naturalist of the Sensational School, who denies that the mole is blind, overlooking all the time the fact that its eyeballs have no optic nerve. "The External Anatomy of the Dor Beetle," by Mr. R. Gillo, is a clear popular account of a despised but most useful little animal. Dr. H. J. Wharton, in his "Notes on the Flora of Hampstead and Caen Wood," points out that the original name of this locality is Ken Wood, and that Kentish Town would be more correct if named Ken-ditch Town. Mr. A. Hammond has studied the "Homologies of certain parts of Insects," and remarks—that some persons are apt to forget that the microscope is but a means to an end. Mr. V. A. Latham continues his instructions on injections used in the preparation of microscopic specimens. At a meeting of the "County of Middlesex Natural History Society," Mr. W. Mattieu Williams remarked suggestively that the ocelli of certain insects might serve for the appreciation of that vast number of waves which are intermediate between those of light and of sound, and which may furnish these creatures with sense-images of which we have no conception.

Persons having the necessary leisure would do well to join the "Postal Microscopical Society."

## CORRESPONDENCE.

*The Editor does not hold himself responsible for opinions expressed by his correspondents, nor can he take notice of anonymous communications. All letters must be accompanied by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.*

### THE FORMATION OF DEW.

*To the Editor of* Scientific News.

Sir,—In your May number expression has been given to approval of Mr. J. Aitken's views on the *formation of dew* by exhalation from the ground below, in contra-distinction to the views of Wells on its formation from the air above.

It may be mentioned that Mr. Aitken may not yet be entitled to have everything explained, as it would not be so easy to account for the heavy dews met with on board ship at sea by his method. These are seen to occur in clear nights, often very early, and to be deposited profusely on the decks, which had already been dried and warmed by the previous day's sunshine and wind. The moisture of the air at sea would appear in our seas not to be derived from the sea direct, but from the clouds above, and the atmosphere becomes charged with aqueous vapour in the daytime by the sun's heat dissipating the visible vesicular water of the clouds floating about. In the cabins and saloons of *iron ships of war*, in their early construction and furnishing, it was found that the walls inside were constantly damp and streaming with moisture, to the extent of injury to health and comfort. The disability was after a time quite rectified by lining them with a non-conducting material, which prevented the access of the warm *moist air* to the cold bare iron bulkheads.

This insanitary dew was solely derived from the air permeating the interior of the ship, and not from the materials of construction, and it would be charged also with the aqueous vapour exhaled from the men on board in addition.—I remain, sir, yours faithfully, Ros-Dew.

*To the Editor of* Scientific News.

Sir,—I have been pleased to see the letter addressed to you by "Ros-Dew," as, although I cannot but differ from him, I am glad to have the subject of my article freely discussed. I have communicated the contents of this letter to my friend, Mr. Aitken, of Darroch, and I have pleasure in stating that we agree upon the answer which I now give.

The difficulty expressed by your correspondent has been observed by many others. There is, however, no real difficulty in the matter. If the surface of the earth were covered with sheet-iron or any substance which gave off no moisture, and if this iron was not in good heat-communication with the earth, then it might get cooled at night to a temperature low enough to cause some of the moisture in the air to condense upon it, just in the same way as the vapour is condensed on the plates inside a ship in which a number of people are living, and giving off a great quantity of vapour. The same thing may be seen inside any large and crowded room in winter when the walls are cold. Towards the end of the meeting the walls will often be seen to be running with moisture. So it is outside; there is always some moisture in the air, and if the surfaces of bodies get cooled below the dew-point, they will have moisture deposited on them, even though no vapour is rising at the time from the ground. There are certain natural conditions when this may be the case, as on board ship, when the temperature of the air is below the dew-point, and not giving off vapour.

These, however, are not the conditions which exist in nature generally. The earth is not cased in iron or other damp-resisting material; and, further, its surface is always at a temperature above the dew-point of the air. Vapour is therefore constantly rising at night from the ground, and as this rising vapour has a higher temperature and is saturated, it is better able to supply moisture to cold surfaces than is the colder and dryer air above. It will therefore be this rising vapour that will get condensed on bodies near the earth.

Dew may be deposited in a perfectly arid country, always provided that the radiating surfaces are not in heat communication with the ground. There is always a possibility of a radiating surface, exposed on a clear night in an arid climate, being cooled by radiation to a temperature below the dew-point of the air. In that case, the dew does not rise from the ground *at the place*, but has risen *long before*, and been *carried* by the winds to where it is deposited.

In this climate, however, these are not the conditions under which dew is deposited. If no vapour rose from the ground, there is, no doubt, plenty in the air to give dew, and no doubt some of the vapour in the air is deposited on bodies high above the ground. But in our climate, in addition to the vapour in the air, there is a constant supply of vapour rising from the ground during the night, and, owing to the high temperature of the ground, this rising vapour has a higher tension than that in the air; and, coming in contact with bodies near the ground, it is naturally this rising vapour which we find deposited on them.

But while we could have dew without this rising vapour, it would not be so abundant, nor be deposited so early in the evening. In that case it would be taken from the air above, and not from the hot and saturated air from below.

The Writer of the Article.

Boulders in Coal.—At the April meeting of the Leeds Geological Association, Mr. C. Brownridge, F.G.S., read a short paper, entitled "Notes on Four Boulders found in the Black Bed Coal and overlying shales and ironstone at Wortley." Mr. Brownridge, after alluding to the fact that the presence of boulders in the coal measures is becoming an important question, said that these interesting discoveries occur from time to time, some having been found in the coalfields of Leicestershire, Lancashire, and the Forest of Dean; but none hitherto appear to have been recorded from that immediate district. The position where these boulders were found is situate in "No. 1 Black Bed Pit." The whole of this neighbourhood is worked for the Wortley fire-clay, and the depth of the black bed coal from the surface is here 30 ft. The largest of the boulders is a coarse gritstone, and nearly spherical in shape. Its dimensions are 2 ft. 6 in. by 2 ft., and it has a fairly smooth, polished face, with slight striæ. This example was found embedded in the "bind," or clayey shales, just overlying the coal. The other three boulders (or pebbles) are much smaller in size, varying from 11 in. by 9 in. to 3¼ in. by 2½ in., and were all found embedded in the black bed coal itself. One of the specimens is a fine-grained grit, the other two being quartzites. The two latter are rather more angular in general shape than the grit specimens, but in all of them the angles are well rounded off and the faces polished. The reason why these stones are thus found located in such unusual positions can only at present be surmised, as the subject is at present rather vague; but the theory has been adduced that they have been carried down by masses of floating vegetation in a manner similar to that recorded by travellers on the Amazon, where, in the swamps and shallows, such masses are seen floating, carrying foreign matter along with them.

Mechanical Reporting.—We understand from *Industries* that Don Pedro Forres, the maker of the astronomical instruments for the San Fernando Observatory, has completed a writing machine, to which he has given the name of "prontuograph," and which is intended to supersede shorthand writing. The present operator can follow a speaker for two hours at the rate of 130 words per minute, and it is stated that any one can do the same with five or six months' practice. The advantage of this machine over shorthand is that writing executed by it can be read by any one after a quarter of an hour's instruction, and copy can be sent direct to the compositors without having to be transcribed. The machine resembles a small pianoforte, and requires about the same amount of pressure.

## THE ROYAL INSTITUTION.

### BRIDGING THE FIRTH OF FORTH.

ON May 20th, Mr. Benjamin Baker, M.Inst.C.E., gave an interesting account of the great bridge now in course of construction. To impress upon his hearers the exceptional size of the Forth Bridge, he said that if one of the tubes of the great Britannia Bridge could be transported from the Menai Straits to the Forth, they would find that it would cover little more than one-fourth of the space to be spanned by each of the great Forth Bridge girders. To get an idea of the magnitude of the latter, let them stand in Piccadilly and look towards Buckingham Palace, and then consider that they had to span the entire distance across the Green Park with a complicated steel structure weighing 15,000 tons, and to erect the same without the possibility of any intermediate pier or support. Let them consider, also, that their rail-level would be as high above the sea as the top of the dome of the Albert Hall is above street-level, and that the structure of the bridge would soar 200 feet yet above that level, or as high as the top of St. Paul's. It was not on account of size only that the Forth Bridge had excited so much general interest, but also because it was of a previously little-known type. It was a cantilever bridge, and one of the first questions asked by the generality of visitors at the Forth was, Why do you call it a cantilever bridge? A cantilever was simply another name for a bracket, but the 1,700 feet openings of the Forth were spanned by a compound structure consisting of two brackets or cantilevers and one central girder. Owing to the arched form of the under side of the bridge, many persons held the mistaken notion that the principle of construction was analogous to that of an arch. In preparing for his lecture the other day, he had to consider how best to make a general audience appreciate the true nature and direction of the stresses on the Forth Bridge, and after consultation with some of the engineers on the spot, a living model of the structure was arranged as follows:—Two men sitting on chairs extended their arms and supported them by grasping sticks butting against the chairs. This represented the two double cantilevers. The central girder was represented by a short stick slung from one arm of each man, and the anchorages by ropes extending from the other arms to a couple of piles of brick. When stresses were brought on this system by a load on the central girder, the men's arms and the anchorage ropes came into tension, and the sticks and chair-legs into compression. In the Forth Bridge they had to imagine the chairs placed a third of a mile apart and the men's heads to be 360 feet above the ground. Their arms were represented by huge steel lattice members, and the sticks or props by steel tubes 12 feet in diameter and $1\frac{1}{4}$ inches thick. There were three main piers at the Forth, known respectively as the Fife pier, the Inch Garvie pier, and the Queensferry pier, and upon each of these there were built huge cantilevers stretching both ways. The Fife pier stood between high and low-water mark, and was separated by a span of 1,700 feet from the Inch Garvie pier, which was partly founded upon a rocky island in mid-stream. Another span of 1,700 feet carried the bridge to the Queensferry pier, which was at the edge of the deep channel. The total length of the viaduct was about $1\frac{1}{2}$ miles, and this included two spans of 1,700 feet, two of 675 feet, being the shoreward ends of the cantilevers, and fifteen of 168 feet. Including piers, there was thus almost exactly one mile covered by the great cantilever spans and another half mile of viaduct approach. The clear headway under the centre of the bridge was 152 feet at high water, and the highest point of the bridge was 360 feet above the same datum.

The lecturer concluded by describing in detail the design, manufacture, and erection of the superstructure, and he exhibited a fine collection of photographs taken from the work in progress.

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## THE SOCIETY OF ARTS.

### THE CHEMISTRY OF PUTREFACTION.

IN the third of the Cantor lectures on the above subject, by Mr. J. M. Thomson, the special subject discussed was a consideration of the more important circumstances, and substances which retard or prevent putrefaction. The exclusion of air, dryness, freezing temperature, and boiling heat, are those physical conditions which retard or prevent the development of putrefaction. In the last case, it is necessary with certain germs that the heat be continued for a long period or repeatedly applied before they are completely stopped from causing decomposition. Substances which act as antiseptic agents, may do so in three ways, as germicides, as disinfectants, and as deodorisers. These antiseptics act by abstracting water from the fermentable substance, by forming with it a compound less liable to putrefaction, by decomposing the ferment, by depriving the surrounding air and the ferment of the necessary oxygen, and, lastly, by killing the fungi and their germs. Of such substances, that which is of most frequent use is charcoal, either wood or animal. It acts by absorbing the gases evolved in the decay, and for this purpose should have been freshly ignited in order that any gases which it has previously absorbed may be first expelled. Ammonia is the gas which is absorbed by the pores of the charcoal better than others, though it will also take up gases which are easily converted into the liquid condition, and such are the most injurious to health. *e.g.*, sulphuretted hydrogen and sulphurous acid. Animal charcoal contains a large amount of mineral matter, and is preferable to vegetable charcoal when a liquid has to be deodorised. The absorbent action of charcoal ceases after a certain time, so that the material requires to be renewed. With sulphuretted hydrogen, besides absorption, the charcoal also effects decomposition of the gas into sulphur and water. Filters containing charcoal and spongy iron are liable, after prolonged action, to become clogged, and should, therefore, be purified or revivified by exposure to heat, or by renewal of the filtering substance. Chlorine is the most important chemical disinfectant and germicide. It acts by supplying oxygen indirectly to the substance, in an analogous way to that in which it bleaches. It, therefore, acts best in the presence of moisture.

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IN the fourth and last of the Cantor lectures, Mr. Thomson said that in addition to the disinfectants alluded to in the last lecture, nitrous fumes have been used for this purpose. They are the general result of the decomposition of nitrites and nitrates, and act as oxidising agents. The heated vapour of the strongest nitric acid is capable of destroying organic matter, and sets fire to such substances as horse hair. Charcoal, iodine, and phosphorus also undergo oxidation in nitric acid very energetically. Other strong mineral acids, *e.g.*, sulphuric acid, act as dehydrating agents, and thus bring about the decomposition of organic substances, rich in the elements of water, by combining with the water they contain. Sulphuric acid has an antiseptic action on substances, by dissolving them. Metallic salts are important as antiseptics and disinfectants. Bleaching powder solution also acts as a deodoriser and decolouriser. Condy's fluid or potassium permanganate is another body which is rich in oxygen, and the green manganate can be readily obtained by fusing manganese dioxide with solid potash in a silver dish. The green manganate can be converted into the purple permanganate by the addition of any oxidising body, and it is then in its most active condition. That permanganate does yield up its oxygen in this way can be shown by its violent action upon glycerine, which takes fire when brought into contact with the solid potassium salt. Chloride of iron and chloride of zinc (Burnett's) are also used as disinfectants. Arsenious acid and boracic acid (boro-glyceride) are used as preservatives. Boracic acid is an extremely good preservative, and is worthy of more general application. Amongst organic substances, carbolic acid is now used to a considerable extent, and is recognised by the compound it produces with bromine, and by the purple colour it gives with a solution of ferric chloride. Lastly, the lecturer recommended a solution of two pounds of ferrous sulphate in a gallon of water, or one of four fluid ounces of carbolic acid to one gallon of water, as the safest materials to be used for household purposes. All materials of no value after disease or sickness, should be burnt, and rooms well ventilated and disinfected by sulphurous acid, after the room is vacated; the sulphurous acid being obtained by heating roll sulphur, or by the combustion of carbon bisulphide. Cleanliness and ventilation are the factors which should be attended to for the prevention and removal of putrefaction and decay.

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## THE INSTITUTION OF CIVIL ENGINEERS.

### ACCIDENTS IN MINES.

AT the concluding ordinary meeting of the session, the paper read was by Sir Frederick Abel, C.B., F.R.S. He said that since 1835 a succession of Royal Commissions and of Parliamentary

Committes had collected and weighed the results of experience, and the views and opinions of miners, mine-managers, and scientific experts, and as a result much improvement had taken place in the working, management, and supervision of mines. But within the last ten years it had been warmly maintained, by competent authority, that the benefits which should accrue from the existing laws were far from being fully realised, while further and more stringent legislation was urgently needed in several directions. In Parliamentary debates great stress had been laid upon the lamentable loss of life due to explosions in mines, but it was scarcely realised that certain causes of accident, which attracted but little public attention, gave rise year after year to a proportion of deaths far exceeding that due to explosions. In support of these opinions, the author submitted a table, compiled from the annual reports of the mine-inspectors for the years 1875 to 1885 inclusive, from which it appeared that, out of 12,315 deaths, only 23·57 per cent. arose from explosions of firedamp, while 40·77 per cent. were due to falls of roof and sides of mine-workings, the remaining 35·66 per cent. being the results of miscellaneous accidents. Moreover, the percentage of deaths due to explosions was very fluctuating, specially heavy mortality having been caused by particularly calamitous explosions in certain years; while, on the other hand, the loss of life caused by falls of roof and sides was not only almost always higher than that due to explosions, but it was also nearly constant. As an instance of the smaller classes of preventible accidents in mines, due to modes of working, reference was made to the custom prevailing in South Wales, of allowing boys to run in advance of the horses and trams used for haulage for the purpose of opening and closing the air-doors. It had been frequently pointed out that the danger arising from this custom would be obviated if boys were stationed at the air-doors, instead of being allowed to run with the trams. The class of accidents connected with the shafts of a mine appeared to have been more successfully grappled with.

The sudden and violent escape of gas accumulated locally under great pressure was also considered, reference being made to various recorded outbursts of gas in England, and to the remarkable occurrence of natural gas in the petroleum districts of the United States and of the Caucasus. The possibility of taking measures for facilitating the comparatively gradual escape of firedamp from gas-bearing strata, so as to relieve the pressure, had received much serious attention. The driving of bore-holes into the coal in advance of the working face had been attended with good results. Recourse had also been had to bore-holes driven into gas-bearing strata contiguous to mine-workings; but the time and cost of carrying out such operations, to any useful extent in localities where such strata were at a distance from the workings, precluded any considerable extension of this system.

The careful examination into the effects produced by explosions in mines had led to a very general realisation of an important element of danger, additional to, and possibly sometimes independent of, the presence of firedamp in the atmosphere of a mine. The discussion of this branch of the subject, and of those relating to the employment of explosives in mines, and the illumination of mine-workings, was reserved for the second part of this paper, not then read.

## THE GEOLOGICAL SOCIETY.

A MEETING of this society was held on May 25th, Prof. J. W. Judd, F.R.S., president, in the chair. The following communications were read:—

1. "On the Remains of Fishes from the Keuper of Warwick and Nottingham." By E. T. Newton, Esq., F.G.S.; with Notes on their Mode of Occurrence, by the Rev. P. B. Brodie, M.A., F.G.S., and E. Wilson, Esq., F.G.S. This paper gave an account of two series of fossil fishes which have been discovered in British Triassic strata. The specimens are very fragmentary, but the rarity of Ganoid fish remains in the English Trias lends considerable interest to these discoveries. The first series noticed were obtained by the Rev. P. B. Brodie in the Upper Keuper of Shrewby, and consist of some half-dozen portions of fish, all small and much broken. The characters of the scales and the positions of the fins, together with as much of the forms as can be made out, point to their belonging to the genus *Semionotus*. The second series were obtained by Mr. E. Wilson, F.G.S., of the Bristol Museum, from Keuper Beds, near Nottingham. A large number of specimens were in this case collected; but all of them are too much broken and crushed out of shape to allow anything very definite to be said about them. Some of these also appear to be *Semionotus;* they agree in size, as well as in some other particulars, with the Shrewby fishes, and may perhaps belong to the same species; but others, on account of their strongly heterocercal tail and ornamented scales, seem to belong to the Palæoniscidæ. The presence of a third form among these Nottingham fishes is indicated by masses of larger scales. The Rev. P. B. Brodie and Mr. Ed. Wilson each appended notes on the Triassic Beds from which the fishes were obtained.

2. "Considerations on the Date, Duration, and Conditions of the Glacial Period with reference to the Antiquity of Man." By Prof. Joseph Prestwich, M.A., F.R.S., F.G.S. After showing how the discoveries in the valley of the Somme and elsewhere, twenty-eight years ago, led geologists who had previously been disposed to restrict the age of man, to exaggerate the period during which the human race had existed, the author proceeded to discuss the views of Dr. Croll on the date of the Glacial epoch. Dr. Croll, who had at first referred this to an earlier phase of orbital eccentricity, commencing 980,000 years ago, subsequently regarded it as coinciding with a minor period of eccentricity that commenced 240,000 and terminated 80,000 years since. This last estimate was chiefly supported by the amount of denudation that had subsequently taken place. The efficacy of the increased eccentricity of the earth's orbit in producing the cold of the Glacial epoch was shown to be very doubtful; for as similar changes in the eccentricity had occurred 165 times in the last 100 millions of years, there must have been many glacial epochs in geological times, several of them much more severe than that of the Pleistocene period. But of such glacial epochs there was no valid evidence. Another inference from Dr. Croll's theories, that each glacial epoch consisted of a succession of alternating cold and warm or inter-glacial phases was also questioned, such alternations as had been indicated having probably been due to changes in the distribution of land and water, not to cosmical causes. The time requisite for such inter-glacial periods, as were supported by geological evidence, was more probably hundreds than thousand of years. Recent observations in Greenland by Professor Helland, Mr. V. Steenstrup, and Dr. Rink, had shown that the movement of ice in large quantities was much more rapid, and consequently the denudation produced much greater than was formerly supposed. The average rate of progress in several of the large iceberg-producing glaciers in Greenland had been found to be thirty-six feet daily. Applying these data and the probable accumulation of ice due to the rainfall and condensation to the determination of the time necessary for the formation of the ice-sheet, the author was disposed to limit the duration of the Glacial epoch to from 15,000 to 20,000 years, including in this estimate the time during which the cold was increasing, or pre-glacial time, and that during which the cold was diminishing, or post-glacial time.

## THE SOCIETY OF CHEMICAL INDUSTRY.

### BACTERIOLOGICAL RESEARCH AND WATER SUPPLY.

DR. PERCY FRANKLAND read a paper on the above subject, in continuation of experiments which he had made known to the society eighteen months previously, since which time he had been conducting a monthly examination of waters for the Local Government Board. He had tested the unfiltered waters as taken from the points of supply, and also in the condition supplied by the companies, giving the number of microbes present in each case. Contrary to what might be expected, the organisms are most numerous in the water in the winter months, perhaps because in summer the rivers are fed more by spring water, and less by surface and drainage waters. In the winter, with increase of rain, the microbes increase also; but in every case the number of microbes was less after filtering. He gave many figures in support of his statements, and mentioned that the companies did not all proceed upon the same lines in their filtering operations, and why some succeeded better than others was a subject for careful study. No conclusion as to the relative excellence of the waters could be drawn from the figures he had given; they merely showed the probable fate of any dangerous organisms which might be present at the unfiltered source.

## RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.

*** *The whole of the papers of the Societies referred to are not included in this list.*

### THE ROYAL SOCIETY.

May 26.—Papers read, "On the Supposed New Force of M. J. Thore," by Mr. W. Crookes. Lecture: "The Dissociation of some Gases by the Electric Discharge," by Professor J. J. Thomson.

June 16.—Papers read, "Experiments on the Discharge of Electricity through Gases," by Professor Schuster; "On Rabies," by Mr. G. F. Dowdeswell; "On the Tubercular Swellings on the Roots of *Vicia faba*," by Professor H. M. Ward; "The Electromotive Properties of the Electrical Organ of *Torpedo marmorata*," by Mr. F. Gotch.

### THE ROYAL INSTITUTION.

May 26, June 2.—Lectures, "The Chemistry of the Organic World," by Professor Dewar.

May 28, June 4.—Lectures, "Victorian Literature," by Professor J. W. Hales.

June 3.—Paper read, "The Application of Photography to Astronomy," by Dr. D. Gill.

June 7, 9, and 11.—Lectures, "The Hellenism of Alexander's Empire," by Rev. J. P. Mahaffy.

### THE SOCIETY OF ARTS.

May 27.—Paper read, "Indian Tea," by Mr. J. B. White.

### ROYAL METEOROLOGICAL SOCIETY.

June 15.—Papers read, "Amount and Distribution of Monsoon Rainfall in Ceylon generally, with remarks upon the Rainfall in Dimbula," by Mr. F. J. Waring; "Note on a Display of Globular Lightning at Ringstead Bay, Dorset, on August 17th, 1876," by Mr. H. S. Eaton; "Ball Lightning seen during a Thunderstorm on July 11th, 1874," by Mr. J. W. Tripe; "Appearance of Air Bubbles at Remenham, Berkshire, January, 1871," by Professor T. G. Bonney.

### SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

May 26.—Papers read, "Underground Telegraphs," by Mr. C. T. Fleetwood; "Driving a Dynamo with a very Short Belt," by Professors Ayrton and Perry.

### GEOLOGICAL SOCIETY.

May 25.—Papers read, "Considerations on the Date, Duration, and Conditions of the Glacial Period, with reference to the Antiquity of Man," by Professor J. Prestwich; "Notes on some Carboniferous Species of *Murchisonia* in our Public Museums," by Miss J. Donald.

June 8.—Papers read, "A Revision of the Echinoidea from the Australian Tertiaries," by Professor P. Martin Duncan; "The Lower Part of the Upper Cretaceous Series in West Suffolk and Norfolk," by Messrs. A. J. Jukes-Brown and W. Hill; "Some Occurrences of Piedmontite-schist in Japan," by Mr. B. Kotô.

### PHYSICAL SOCIETY

May 28.—Papers read, "Note on Transformers for Electric Distribution," by Professor S. P. Thompson; "Magnetic Torsion of Iron Wires," by Mr. S. Bidwell; "A Strain in a Beam fixed at both ends," by Professors W. E. Ayrton and J. Perry.

June 11.—Papers read, "Note on Beams fixed at both ends," and "Note on Magnetic Resistance," by Professors W. E. Ayrton and J. Perry.

### ROYAL STATISTICAL SOCIETY.

June 14.—Paper read, "The Statistical Story of the Suez Canal," by Mr. J. Rabino.

### ROYAL MICROSCOPICAL SOCIETY.

June 8.—Papers read, "Monograph of the Genus Lycoperdon," by Mr. G. Massee; "Remarks on the Foraminfera, with especial reference to their Variability of Form, illustrated by the Cristellarians," by Professor T. Rupert Jones and Mr. C. D. Sherborn.

### SOCIETY OF CHEMICAL INDUSTRY.

June 6.—Papers read, "The Alkaloids—the Present State of Knowledge concerning them, and the Methods Employed in their Investigation," by Dr. H. E. Armstrong; "Notes of a Recent Visit to some of the Petroleum-producing Territories of the United States and Canada," by Mr. B. Redwood.

### ROYAL DUBLIN SOCIETY.

June 1.—Papers read, "On the Presence of Ice in the Upper Atmosphere, and the Conditions under which it Exists," by Mr. G. J. Stoney; "On a Combination of Dry and Wet Methods applicable to Qualitative Analysis," by Mr. W. E. Adeney; "On Professor Poynting's query as to Electrical Actions across Conductors," by Professor G. F. Fitzgerald; "On Inversion applied to Centrobaric Bodies," by Mr. T. Preston; "On Twisted Copper Wire," by Mr. S. M. Dixon.

### BALLOON SOCIETY.

May 27.—Lecture, "Convalescent Homes: their Value, their Management, and How they are Abused," by Mr. R. Frewer.

### ATHENÆUM SOCIETY.

June 9.—Paper read, "Borax: the Forms in which it is Found, and its Commercial Importance," by Mr. W. H. Frith.

### INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

June 1.—Paper read, "The Enlargement of Westland-row Terminus, with a Sketch of the Early History of the Dublin and Kingstown Railway," by Mr. Thomas B. Grierson.

### IRON AND STEEL INSTITUTE.

May 27.—Papers read, "Some investigations as to the Effects of Different Methods of Treatment of Mild Steel in the Manufacture of Plates," by Mr. J. Riley; "The South Chicago Works of the North Chicago Rolling Mill Company," by Mr. E. C. Potter.

### CHESTERFIELD AND MIDLAND COUNTIES' INSTITUTION OF ENGINEERS,

June 18.—Paper read, "A Simple Safety Blasting Cartridge for use in Mines," by Mr. W. H. Routledge.

### ROYAL COLONIAL INSTITUTE.

June 14.—Paper read, "Colonization," by Colonel Sir Francis W. De Winton.

### EDINBURGH PHOTOGRAPHIC SOCIETY.

June 1.—Papers read, "Pyrogallic Acid and its Uses in Photography," by Dr. T. W. Drinkwater; "Stripping Films," by Mr. J. M. Turnbull; "Copying without Texture," by Mr. H. Cameron; "A New Shutter Release," by Mr. Thomas Wardale.

### THE MINING ASSOCIATION AND INSTITUTE OF CORNWALL.

June 14.—Papers read, "The Ventilation of Metalliferous Mines," by Mr. W. Husband.

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Institution of German Engineers.—The annual meeting of this institution is to be held in Leipzig, from the 15th to the 18th August, when visits will be made to the various local industrial establishments. A large number of members is expected to attend.

The Photographic Convention of the United Kingdom.—Arrangements for this meeting in Glasgow are in progress. The convention will extend over one week, commencing on Monday, 4th July. Members who wish to be present should send their names to the local secretary, Mr. James Davie, 36, Darnley-street, Pollokshields, Glasgow.

A Volunteer Cyclist's Corps.—We are asked to state that the members of the Balloon Society have passed resolutions in favour of establishing a Volunteer Cyclist Corps, and that a committee is being formed to promote this object.

We have received from Mr. A. G. Dawson, of 14, Ivy-lane Paternoster-row, "Adams' Patent Line Divider." It consists of a sheet of tracing cloth, mounted on rollers, and on which are printed a number of parallel lines; these are crossed by other lines gradually diverging from each other. The sheet is placed over the line to be measured, and the divisions can be pricked off. The device is simple and ingenious. It should be the means of saving a good deal of time in the draughting office. The price is two shillings and sixpence.

A new Classified Catalogue of the Library of the Royal Institution of Great Britain, with Synopsis and Indexes of authors and subjects, including the Additions to 1882. By Benjamin Vincent, Assistant Secretary and Keeper of the Library. 2 vols. 8vo. Half-bound. Price to members, 14s.; to Non-Members, 21s. 6d. Volume II. (just published). Price to Members, 6s.; to Non-Members, 8s. 6d. With Additions 1882-6.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

6300.—WALTER BETHELL, 20, High Holborn, London. "Packing employed for stuffing boxes of steam-engines, pumps, and the like." 29th April, 1887.

6314.—AMBROSE FLEMING, 4, St. Ann's Square, Manchester. "Signalling in foggy weather upon railways." 30th April, 1887.

6339.—ISIDRO PLOU, 67, Strand, London. "Preventing railway and other vehicles from leaving the rails." (Complete specification.) 30th April, 1887.

6354.—PAUL KIRCHOFF, 47, Lincoln's Inn Fields, London. "A rotary steam-engine or motor." (Complete specification.) 30th April, 1887.

6367.—CUTHBERT BURNETT, 5, Burn Terrace, Hartlepool. "Boring long holes in coal mines." 2nd May, 1887.

6409.—ROOKES EVELYN BELL and WILLIAM AUGUSTUS KYLE, 55 and 56, Chancery Lane, London. "Dynamo-electric machines and motors." 2nd May, 1887.

6416.—WILLIAM WHITEHEAD and ALFRED EMLEY, 24, Southampton Buildings, London. "Boilers." 2nd May, 1887.

6466.—MATTHEW HENRY SIMPSON, 4, South Street, Finsbury, London. "Rotary engines." 3rd May, 1887.

6516.—WALTER PAYTON, Brooklyn House, Larkfield, Richmond. "Steam-engines." 4th May, 1887.

6565.—OMER DELHAYE, 15, Ritson Road, Dalston. "Process of dyeing vegetable or animal fibres." 4th May, 1887.

6570.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Albert Newton Russell and Addison Brill, United States. "Machine guns." 4th May, 1887.

6614.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Antoine Angély Lagane, France. "Philosophical toys or automatons." 5th May, 1887.

6618.—HENRY TEPPING, 55 and 56, Chancery Lane, London. "Apparatus for operating the slide valves used in marine and other steam-engines." 5th May, 1887.

6621.—JOSEPH DEVENPORT FINNEY ANDREWS, 28, Southampton Buildings, London. "Electro motors." 5th May, 1887.

6623.—WILLIAM HOWARD TASKER, 53, Chancery Lane, London. "Manufacture of plates or elements for voltaic batteries. 5th May, 1887.

6633.—WILLIAM HENRY OSBORN, 6, St. George's Place, Great Hampton Row, Birmingham. "Ornamental designs and lettering on plates of metal." 6th May, 1887.

6673.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from John Robert Cannon, Canada. "Photographic instruments." (Complete specification.) 6th May, 1887.

6681.—ROOKES EVELYN BELL CROMPTON, Arc Works, Chelmsford, and JOHN CHARLES HOWELL, Carffair, Llanelly. "Secondary batteries or electrical accumulators." 6th May, 1887.

6715.—CHARLES KINGSTON WELCH, High Road, Tottenham. "Crank and eccentric gearing for velocipedes, engines, and other machinery." 7th May, 1887.

6742.—HENRY GRAFTON, 113, Cannon Street, London. A communication from William Russell Grafton, Egypt. "Screw propellers." 7th May, 1887.

6754.—ROOKES EVELYN BELL CROMPTON and JAMES SWINBURNE, Arc Works, Chelmsford. "Dynamo-electric machines." 9th May, 1887.

7013.—DAVID APPLETON and FREDERICK ALTONA BINNEY, 15, Princess Street, Manchester. "Electro-plating rollers and other articles." 13th May, 1887.

7016.—ALGERNON JASPER LYON, 53, St. Andrew's Street, Cambridge. "Cartridge box." 13th May, 1887.

7030.—CHARLES MALTBY-NEWTON, Flackwell Heath, near High Wycombe, Buckinghamshire. "Plates, with composition for electric batteries." 13th May, 1887.

7079.—ERNEST WILSON, 9, Staple Inn, London. "Dynamo-electrical machines." 14th May, 1887.

7096.—ALAN ARCHIBALD CAMPBELL-SWINTON, 75, Queen Victoria Street, London. "Membranes for electro-magnetic telephone instruments." 16th May, 1887.

7105.—HENRY ISAAC DIXON and WILLIAM BEAUMONT, Cornish Place, Sheffield. "Cartridge extractors." 16th May, 1887.

7118.—CHARLES STUART STANFORD WEBSTER, 4, New Court, Lincoln's Inn, London. "Apparatus for inhaling ammonium chloride." 16th May, 1887.

7130.—JOHN ADOLF NORDSTEDT, 4, South Street, Finsbury, London. "Cutting worm wheels." (Complete specification.) 16th May, 1887.

7198.—WILLIAM AUGUSTUS BALDWIN, 323, High Holborn, London. "Obtaining aluminium from its ores or from aluminiferous earths, or earths containing alumina and of combining aluminium with other metals." (Complete specification.) 17th May, 1887.

7203.—CHARLES THOMAS SCHOEN, 323, High Holborn, London. "Combined superheaters and hydrocarbon burners." (Complete specification.) 17th May, 1887.

7215.—DAVID JOHN MORGAN, 1, Queen Victoria Street, London. "Lighting ships to indicate the direction of steering." 17th May, 1887.

7217.—JAMES CLARKSON and SHADLOCK WILKINSON, 8, Quality Court, London. "Water-closets." 18th May, 1887.

7260.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Carl Enke, Germany. "Rotary air propellers." (Complete specification.) 18th May, 1887.

7360.—GUY CAREY FRICKER, 9, Montserrat Road, Putney, S.W. "Dynamo-electric machines." 20th May, 1887.

7369.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from Alliston Barker, United States. "Typewriting machines." 20th May, 1887.

7394.—JOHN AUGUSTINE KINGDON, 1, Queen Victoria Street, London. "Primary electric batteries." 20th May, 1887.

7431.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Max Engelhardt, Germany. "Electric clocks." (Complete specification.) 21st May, 1887.

7527.—RUDOLPH M. HIMTER, 45, Southampton Buildings, London. "Electric motors or dynamo-electric machines." (Complete specification.) 25th May, 1887.

7538.—CHARLES MARCH and WILLIAM DICK, 87, St. Vincent Street, Glasgow. "Nail-making machines." 25th May, 1887.

7548.—JOHN GOTT, 3, Church Court, Old Jewry, London. "Curb keys for telegraph cables." 25th May, 1887.

7554.—CHARLES EDWARD ALLAN, 87, St. Vincent Street, Glasgow. "Navigational signalling apparatus." 25th May, 1887.

7701.—CARL FRIEDRICH CLAUS, HENRY LIVINGSTONE SULMAN, and EDWARD ELHANAU BERRY, 76, George Street, Euston Road, London. "Manufacture of soda by the ammonia soda process." 27th May, 1887.

7733.—JAMES YATE JOHNSON, 47, Lincoln's Inn Fields, London. A communication from Farbenfabriken vormals Friedrich Bayer and Co., Germany. "For manufacture of dyes." 27th May, 1887.

7844.—EDWARD MICHAELIS, ALFRED SMETHURST (of the firm of Alfred Smethurst and Co.), and CHARLES WOOD, 4, Mansfield Chambers, 17, St. Ann's Square, Manchester. "Gig mills employed in finishing woven fabrics." 31st May, 1887.

7865.—FREDERICK GEORGE, Uley, Dursley, Gloucestershire. "Dynamo-electric and electro-dynamic machines." 31st May, 1887.

7937.—FREDERICK STOCK, 76, Chancery Lane, London. "Magazine guns." 1st June, 1887.

8129.—LEONHARD ADOLF STAUB, 6, Lord Street, Liverpool. "Manufacture of carbonate of soda." 6th June, 1887.

8145.—DIMITRI SKRIVANOW, 24, Southampton Buildings, London, W.C. "Galvanic batteries." 6th June, 1887.

8220.—THOMAS FLETCHER, 70, Market Street, Manchester. "Incandescent gas fires." 8th June, 1887.

8258.—HEINRICH BILLETER, jun., 45, Southampton Buildings, London. "Automatic lubricators." 8th June, 1887.

8262.—WILLIAM MORRIS MORDEY, 46, Lincoln's Inn Fields, London. "Electric generators." 8th June, 1887.

8269.—HENRY SAMUEL PRICE, 36, High Holborn, London. "Water meters." 8th June, 1887.

8270.—CHARLES DENTON ABEL, 28, Southampton Buildings, London. A communication from Paul Brennicke, Germany. "Valves and valve gear for steam engines." (Complete specification.) 8th June, 1887.

8272.—FREDERICK PELHAM WARREN, 67, Longridge Road, Earl's Court, London. "Appliances for saving life at sea." 9th June, 1887.

8276.—ANDREW LINMERE DOWIE, 87, St. Vincent Street, Glasgow. "Treating iron, and castings thereof." 9th June, 1887.

8277.—WILLIAM JUKES, 8, Quality Court, London. "Manufacture of steel, and apparatus connected therewith." 9th June, 1887.

8302.—WILLIAM HENRY CHILDES and WILLIAM LESLIE MILNE, 6, Lord Street, Liverpool. "Signalling apparatus for railways." 9th June, 1887.

8304.—GEORGE HUGHES, 6, Lord Street, Liverpool. "Lifeboats, or lifeboat deck seats." 9th June, 1887.

# Scientific News

## FOR GENERAL READERS.

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## CURRENT EVENTS.

Banquet to Professor Tyndall.—This entertainment was indeed a remarkable one, and, as Professor Tyndall himself said, the assembly was in intellectual measure as distinguished as any of the same size ever addressed by man. Most of the speeches were appropriate and good, especially that of Professor Tyndall himself, from which we quote the following: "Thus early, you will see I was alive to the importance of technical education; and I am no less alive to it now. You will not, therefore, misunderstand me when I say that to keep technical education from withering, and to preserve the applications of science from decay, the roots of both of them must be well embedded in the soil of original investigation. And here let it be emphatically added, that in such investigation practical results may enter as incidents, but must never usurp the place of aims. The true son of science will pursue his inquiries irrespective of practical considerations." In illustration of the fact that the investigator often taps springs of practical power which otherwise he would never have reached, he said: "I need not go further than the fact that in this our day a noble and powerful profession has been called into existence by his discovery of magneto-electricity. The electric lamps which mildly illuminate our rooms, the foci which flood with light of solar brilliancy our railway stations and public halls, can all be traced back to an ancestral spark so small as to be barely visible. With impatient ardour Faraday refused to pause in his quest of principles to intensify his spark. That work he deliberately left to others, confidently predicting that it would be accomplished. And prompted by motives both natural and laudable, but which had never the slightest influence on Faraday, others have developed his spark into the splendours which now shine in our midst."

Professor Tyndall then reminded his hearers that, passing beyond the limitations of the individual, science as a whole had indeed accomplished great things during the Victorian epoch. The discovery of the principle of Gravitation, the bit and bridle whereby the compelling intellect of Newton brought the solar system under the yoke of physical laws, could not be included, but he added: "Quite fit to take rank with the principle of Gravitation—more momentous, if that be possible—is that law of Conservation which combines the energies of the material universe into an organic whole." The second generalization, he said, was like unto the first in point of importance, though very unlike as regards its reception by the world. For whereas the principle of Conservation with all its far-reaching, and, from some points of view, tremendous implications, slid quietly into acceptance, its successor evoked the thunder-peals, which, it is said, always accompany the marriage of thought and fact. "For a long time the scent of danger was in the air; but the evil odour passed away; the air is fresher than before; it fills our lungs and purifies our blood, and science is able to add to the law of Conservation the principle of Evolution."

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The Pasteur Treatment of Hydrophobia.—A committee of thoroughly competent men of science was appointed by the Local Government Board in April last to inquire into M. Pasteur's system of inoculation as a remedy for hydrophobia. The committee consisted of Sir James Paget (chairman), Dr. Lauder Brunton, Dr. George Fleming, Sir Joseph Lister, Dr. Quain, Sir Henry Roscoe, and Professor Burdon Sanderson, with Professor Victor Horsley as secretary. The first steps taken by the committee were to visit Paris, so as to obtain information direct from M. Pasteur, to observe his method of treatment, and to investigate a considerable number of the cases of persons inoculated by him. A careful series of experiments, under Professor Horsley's superintendence, was also instituted on the effects of the inoculation on the lower animals. The inquiry seems to have been conducted in a thorough and impartial manner, and the report now issued is a valuable contribution to our knowledge of the subject; it is moreover satisfactory to find that the committee are unanimous in the conclusions they have arrived at. They are entirely in favour of M. Pasteur's system, and this must be especially pleasing to the great pathologist himself, as only lately some medical authorities in Italy reported against it. We give elsewhere extracts from the committee's report, which is alike creditable to the discoverer of the treatment and to those who have investigated it in so truly scientific a spirit, without a tinge of national or professional jealousy.

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Technical Education in England.—We are gradually awakening to the national importance of promoting technical education, and active steps are now being taken in several directions to give effect to the recommendations of Sir Henry Roscoe and other competent authorities associated with him, who have given the matter their careful attention. At the same time we believe there are still many who have a very inaccurate idea of what has already been done, and who are consequently unable to give their best thought to the difficult questions involved. Moreover, their sympathy with the movement cannot be as full as it might be, were they to see clearly that their own individual interests are directly or indirectly involved. The end in view is a very practical one indeed, neither more nor less than how best to train our working classes to make the fittest use of the materials they have to work with. Mere skill in handicraft is not enough; they must also understand the *technique* of the subject they are dealing with. Rule of thumb has had its day, but will not suffice any longer; there must now be a more exact knowledge of cause and effect, and of the principles underlying the processes to be worked out.

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The danger of such a movement as this is that it may become too theoretical, too professorial, unless checked and influenced by those who have actual trade experience of the practical details to be considered. After all, the question is an industrial one, and we want the shrewd sense of the community brought to bear on it, as well as the teaching of theoretical experts. If these forces are combined the ultimate gains cannot fail to be real and great; we therefore strongly recommend manufacturers and others to make themselves acquainted with the actual doings of the organisations already at work. Not that we consider them by any means faultless, but those practically engaged in the arts and manufactures will then be in a position to give welcome and helpful advice to those who are directing the movement. We give elsewhere a translation of a paper by Sir Philip Magnus, which was read before the Industrial Section of the International Technical Education Congress held a short time since at Bordeaux. This gives a clear account of the growth of Technical Education in this country, and as a statement of facts, it will doubtless be welcome to many of our readers. We may not agree with all that has been done, and may be somewhat afraid of an abuse of the system of "payment by results," and of giving too readily certificates of proficiency; but in general terms we cordially approve the movement, and at this early stage are not disposed to dwell unnecessarily upon details.

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Marine Biological Association.—The third annual general meeting of this association was recently held in the rooms of the Linnæan Society. The report for the past year stated that the attention of the council had been chiefly devoted to the superintendence and fitting up of the laboratory at Plymouth, and to preparations for the work of the association in connection with it. It is expected that the laboratory will be ready for partial occupation in the present summer; but the tanks and circulation of sea water cannot be completed for some months to come. The council had decided to issue to members of the association a journal, which would serve not only for the circulation of the official publications, but also as a means of inquiry and exchange of information among those who are interested in marine biology in its relation to the sea fisheries of the United Kingdom. It is most important that there should be a first-rate biological library in the Plymouth laboratory, and the council trust that members and friends of the association will assist in the formation of such a library by gifts of books. The association is willing and anxious to co-operate with individuals or associations in any part of the British Islands who are engaged in the study of the natural history of marine fishes, or in researches in marine biology. It is fully the intention of the council to promote real scientific research, and to discourage mere dilettante work, and their efforts are deserving of cordial support.

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Agricultural Experiments.—Under the auspices of the Royal Agricultural Society some useful field experiments have been carried out at Woburn. The primary object of these experiments, which were commenced in 1877, was to test the accuracy of the estimated values of manure, obtained by feeding the live stock on different kinds of purchased foods. In order to test by actual farming experience the correctness of the estimated values, sixteen acres of light brown soil were devoted to rotation experiments. To half the plots manure made from feeding on cotton cake and maize meal respectively was applied, and on the other half artificial equivalents of the manurial constituents of each of these foods were used. For several years there was practically no difference in the results, and if only the manures made by feeding with cotton cake and maize meal had been applied, it might have been supposed that the chemists' estimates of manurial values were entirely wrong; but the only possible conclusion was that the field was so much enriched by previous manuring as to continue to yield its maximum produce. Upon this fact being ascertained, measures were adopted for exhausting the excessive fertility of the soil. At the same time the acre plots were divided, one half of each being manured less liberally than before, and the other not at all. The result last year was that in three out of four cotton-cake plots a considerably larger yield of wheat was obtained than on the corresponding maize-meal plots, while it was equal in the remaining pair.

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In another set of experiments wheat and barley have been grown year after year for ten successive years with the aid of various manures, as at Rothamsted, and the results so far have in the main confirmed the conclusions derived from the experiments at that place. Mineral manures alone have produced very little effect, while nitrogenous manures, either alone or in combination with minerals, have never failed to bring forth an extra yield of corn, as compared with that of the unmanured plots. It is also to be noticed, by way of commentary upon the impression that the soil is exhausted by the application of nitrate of soda or sulphate of ammonia, that plots on which these manures alone have been applied every year have yielded largely increased crops, and the soil as yet shows no sign of exhaustion. In some seasons nitrate of soda has given the best results and in others sulphate of ammonia, the former doing best in a dry season and the latter in a wet one. Year after year on plots from which the nitrogenous manure previously applied has been withheld the yield of corn has been greatly reduced, in spite of the continued application of mineral manures, such as superphosphate of lime, and sulphates of potash, soda, and magnesia. The nitrogenous manures give striking results, while plots manured with minerals only have little if any more wheat, and not a great deal more barley on them than the unmanured plots. As usual, the best results of any are attained by the use of very liberal dressings of nitrogenous and mineral manures in combination.

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The Public Services in Relation to Science.—In proposing this toast at the dinner recently given to Professor Tyndall, Sir Lyon Playfair remarked that undoubtedly the public services were intimately connected with science, and were profoundly affected by its progress, but unfortunately the truth was only beginning to be recognised in this country. In the United States scientific men were attached to all public offices, but in this country the attachment was of the loosest possible character. Nevertheless, science had undoubtedly affected our public services in the most profound way. The telegraph had altered the whole system of commerce, as well as the methods and the powers of government. At our great naval review, it would be interesting to imagine Elizabeth's thirty small ships, which conquered the Armada, sailing through two miles of modern ironclads. The largest piece of ordnance used in the Crimean War cost less than a single shot fired from the huge guns of our ironclads. But it was in peace rather than in war that science rejoiced in aiding government. A strong feeling was arising that we must improve our intellectual position as a nation, and this at last was being recognised by the Government.

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Sir Lyon Playfair added that a material index of progressive civilisation had always been desired, and that Liebig contended that the best index of civilisation was the quantity of soap consumed. When the Queen ascended the throne we consumed per head $7\frac{3}{4}$ pounds of soap, and now we use 10 pounds per head. The consumption of paper, he thought, was a more reliable index. At the beginning of the Queen's reign the consumption was $1\frac{1}{4}$ pound of paper yearly, now it was 12 pounds; while in the United States it was 10 pounds; in Germany, 9 pounds; in France, 8 pounds; and in Italy 4 pounds. But the main question was whether we were developing the national intellect at the same rate as other nations, and he concluded by saying that our general intelligence is still high, but our trained scientific intelligence is low. Our secondary education in all matters relating to science is far behind that of the United States, Germany, and France. Neither the Government, nor the people governed, could go on in simple faith on our practical aptitudes by relying on a blind and vain empiricism, like a tree severed from its roots.

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British Association Meetings.—We sincerely trust that the recommendations of Professors Lodge and Silvanus Thompson as to improving the sectional procedure will not pass unheeded by the powers that be. Their suggestions refer more particularly to the mathematical section (A), but there is little doubt that in nearly all the sections there is a decided want of business-like organisation, and a growing tendency to allow too many papers to be hurriedly read, with little or no discussion. It is all very well to cater for the popularity of these gatherings by promoting excursions and garden parties, but it is indeed a grievous pity that such amusements should be allowed to interfere with the real business in hand, which is the "advancement of science." At these meetings isolated workers and others who are genuinely interested in scientific subjects, are brought face to face with men of the highest attainments, and they naturally wish to profit by the occasion. This wish, however, is often not realised, and we remember hearing last year's meeting described as a mere "scientific lark." It would doubtless be a great improvement if each section were to begin work at 10.30 punctually; if the rule were enforced that no paper should be read which had not been submitted at least a fortnight before the meeting; and if each sitting were to begin with the papers of more general interest. The public would then know that in each section this rule would hold good, their attendance would doubtless be more regular, and there would be less of that tiresome coming and going hitherto so prevalent. The meeting at Manchester will be in the heart of one of our greatest industrial centres, where the applications of science are numerous and important, and without in any way wishing to curtail a fair allowance of amusements, we trust the ruling motto will be, "Business first, pleasure afterwards."

## GENERAL NOTES.

Photographing Projectiles.—A photographer at Pesth has succeeded in taking photographs of projectiles, fired from a Werendler gun, while having a velocity of 1,300 feet per second. The projectiles appeared on the impressions enveloped in a layer of air hyperbolic in form.

Melting Gold at Low Temperature.—Gold will only melt at a comparatively high temperature, as we all know, but what is not generally known, the *Jewellers' Journal* says, is that if two per cent. of silica be added to the gold, it can be melted over the flame of a common candle.

The Electric Light in the German Army.—It is said that German regiments on a night march will in future be preceded by a waggon carrying a powerful electric light, by which, it is claimed, the road ahead can be seen, and the danger of surprise by an enemy considerably lessened.

Electric Light for Omnibuses.—One of the omnibuses of the London Road Car Company, running between Liverpool Street and Victoria Station, has been supplied with an "Eclipse" primary battery, which is used for lighting an incandescent lamp. So far the trial is said to be very satisfactory.

Natural Gas.—While boring an artesian well at Lyons, New York, natural gas was discovered quite unexpectedly. In order to see down into the well a lighted candle was lowered a few feet, when an explosion followed, and a flame shot into the air. It is now proposed to form companies for boring wells for natural gas in this district.

The Autographometer.—M. Floran de Villepigne, of Paris, has devised an instrument which records automatically the topography and difference of level of all places over which it passes. It is carried about on a light vehicle, and those who wish to use it have nothing to do but to haul it, or have it hauled, over the ground of which they desire to have a plan.

Gold Alloy.—According to the *Jewellers' Journal*, a pretty alloy, said to resemble gold exactly, can be made with sixteen parts of copper, one of zinc, and seven of platinum. The copper and platinum are first covered with borax, then with powdered charcoal, and are afterwards melted, the zinc being added. The alloy thus produced is exceedingly malleable, and can be drawn into the finest wire, while it is said not to tarnish.

Artificial Ivory.—A substance resembling ivory, white and very hard, can be made from good potatoes washed in dilute sulphuric acid, and then boiled in the same solution until they become solid and dense. They are then washed free from the acid and slowly dried. This ivory can be dyed and turned and made useful in many ways. The artificial ivory that will receive and retain a polish has not, however, yet made its appearance.

A Great Engineering Feat.—We learn from *Iron* that a remarkable feat of engineering was recently performed in America by the shifting *en masse* of an iron railway bridge, weighing 1,600 tons a distance of 50 feet, at Holmesburg Junction, on the Pennsylvania Railroad. The operation was performed in less than twelve minutes, traffic was uninterrupted, and in an hour after the change an express train from New York to Philadelphia passed over the structure.

The Electric Light in Washington.—We learn from a contemporary that a curious result of the electric light has been observed in several of the public buildings in Washington, where it is used. It seems to constitute an immense attraction for multitudes of minute insects, and as a consequence spiders have increased enormously, so that in many cases the architectural outlines of cornices and of capitals of pillars have become obscured by the quantity of spiders' webs overlying them.

Liquid Fuel.—On the Pennsylvania Railroad a successful trial has been made with liquid fuel applied to a locomotive. The fuel is the residue obtained from the oil refineries, and was carried in barrels on the tender. The furnace of the engine was specially lined with fire brick, and the oil was fed into the furnace by means of a steam jet, thus producing a spray and obtaining perfect combustion. The apparatus is very similar to that used on some of the steamers on the Caspian Sea. In making the run of 116 miles, between eleven and twelve barrels of oil were used, the average consumption of coal on the same run being 3 tons 8 cwt.

Aluminium—Silver Alloy.—Alloyed with a small percentage of silver, aluminium loses much of its malleability, but with five per cent. of silver it can be worked well, and takes a more beautiful polish than the pure metal. With three per cent. of silver it is very suitable for philosophical instruments, being harder and whiter than the pure metal, and it is not tarnished even by sulphuretted hydrogen. With small amounts of silver it appears very suitable for scale beams, and is now frequently used for this purpose. The alloy containing five per cent. of silver has often been suggested for coins of small denominations, as it is hard, bright, and retains its lustre in handling.

Submarine Telephony.—Professor Trowbridge's plan of submarine telephony, in which speech was to be transmitted between vessels at sea without the aid of any connecting wire, has been abandoned as impracticable, but the system upon which Mr. Edison has been experimenting in Florida is more promising of good results. In this system the telephone signals, by long and short explosive sounds instead of by spoken words and communications, have been successfully exchanged through the water between vessels from three to four miles apart, with the prospect that the working limit may be increased with improvement in the apparatus.—*Electrical Review.*

An Electric Trumpet.—We learn from *La Nature* that an electric trumpet has been devised by M. Zigang. It consists of a short brass tube mounted on wood, and containing an electro-magnet whose ends face a vibrating plate, on which is fixed a small piece of soft iron. Against this plate-armature rests a regulating screw with a platinum point, which serves for automatic interruption, by vibration of the armature. With two Leclanché elements a musical sound is obtained, which may be varied in pitch, intensity and timbre by means of the screw. This instrument may be usefully employed in signalling on ships, railways, tramways, etc.; it may also serve as a receiver for signals of the Morse type.

The Products of a Ton of Coal.—Besides gas, a ton of gas coal will yield about 1,500 pounds of coke, 20 gallons of ammonia water, and 140 pounds of coal tar. Destructive distillation of the coal tar gives 69·6 pounds of pitch, 17 pounds of creosote, 14 pounds of heavy oils, 9·5 pounds naptha yellow, 6·3 pounds of napthaline, 4·75 pounds of naphthol, 2·25 pounds of alizarine, 2·4 pounds of solvent naptha, 1·5 pound of phenol, 1·2 pound of aurine, 1·1 pound of aniline, 0·77 pound of toludine, 0·46 pound of anthracine, and 0·9 pound of toluene. From the last-named substance is obtained the new product known as saccharine, which is said to be 230 times as sweet as the best cane-sugar.

The Sense of Smell in Dogs.—The results of some careful experiments on this subject by Mr. G. J. Romanes have been communicated to the Linnæan Society. He finds that not only the feet, but the whole body of a man exhale a peculiar or individual odour, which a dog can recognise as that of his master amid a crowd of other persons; that the individual quality of this odour can be recognised at great distances to windward, or in calm weather to great distances in any direction; and that even powerful perfumes may not overcome this odour. Yet a single sheet of brown paper, when stepped upon instead of the ground, and afterwards removed, was sufficient to prevent Mr. Romanes' dog from following his trail.

Antiseptic for Garden Crops.—According to Dr. A. B. Griffiths, iron sulphate is an antiseptic for most of the virulent epidemics which attack field and garden crops. These diseases are due to microscopic fungi, whose structures are built up in a manner somewhat different from the corresponding parts in other plants. It appears that the cellulose in these fungi is acted upon by iron sulphate, whereas in the higher plants the cellulose of the cell walls is not influenced. The iron sulphate is said to destroy the cellulose of the fungi, but does not affect that of the attacked plant. It is therefore an antidote and destroyer of such parisitic germs and fungi as the potato disease, wheat mildew, etc. This should be of great importance to horticulturists and agriculturists.

A School of Brewery.—We learn from *Industries* that the annual congress of brewers, chemists, and others interested in this trade, was recently held at Graz, and that one of the questions which received attention from the congress was that of technical education. It has been resolved to institute, in connection with the Vienna technical museum, a school for brewery and a brewers' laboratory. As the members of the congress are not very sanguine of obtaining Government aid in the shape of a subvention for this undertaking, they have resolved to form a society with the object of raising the necessary funds, and they are sanguine that there will be no difficulty in obtaining the financial support of brewers and others, since this industry occasions a large export trade, and is one of the most important in Austria.

Inventions Wanted.—A contemporary enumerates the following as among the inventions which are specially needed at the present time: Macaroni machinery, good red lead pencils, type-writers that will work on account-books and record-books, indelible stamp-cancelling ink, a practical car-starter, a good railway car-ventilator, better horse-shoes, locomotive head-lights, an instrument for measuring the velocity of wind-currents, apparatus for measuring the depth of the sea without sounding by line, piano-lid hinge which shall be flush on the outside, good fluid Indian ink for draughtsmen, a good metallic railway tie, an effective cut-off for locomotives, a method of alloying copper and iron, and a moulding material for iron and brass casting, capable of giving a mould that can be used over and over again.

A New Light for Instantaneous Photographs.—At a recent meeting of the Berlin Physical Society, Prof. C. W. Vogel communicated the most recent discovery in connection with instantaneous photography, by which it is now possible to obtain instantaneous photographs, not only at night, but also in the darkest places. Messrs. Goedicke and Miethe have prepared a mixture of pulverized magnesium, chlorate of potash, and sulphide of antimony, which when ignited produces an explosive, lightning-like illumination of such intensity that by means of it an instantaneous photograph can be taken. The speaker then gave a demonstration of the discovery by taking photographs of several persons present. He used the artificial light, of which each flash lasted one-fortieth of a second, and in a few minutes produced a picture during the meeting. The powders, as prepared by the discoverers, cost only a few pfennige each.

Organic Matter in Drinking Water.—Mr. A. W. Hare, M.B., recently read a paper on the above subject, chiefly with reference to the biological side of the question. He stated that even in distilled water there are certain forms of organisms which survive for a considerable time; but that such water is always perfectly safe for drinking purposes. Water taken from deep wells is very free from microbes, but when left for a time in the open air it becomes more crowded with them than river water. In regard to river water, he pointed out that it is a popular fallacy that water from a rushing torrent is safer for drinking purposes than water from a sluggish stream. He stated that the reverse is the fact, and in the case of water contaminated by sewage he said that after ten or twelve days there is a smaller number of organisms present than in river water, the reason being that during the first two or three days they had multiplied to such an extent as to exhaust the pabulum in the water.

Preservation of Wooden Poles.—A simple method of treating wood with preservative solutions is employed in Norway for telegraph poles. After the poles are set in place a man goes from pole to pole with an auger, with which he bores a hole in each post, beginning at a point about two feet above the ground, and boring obliquely downward, at as small an angle as possible with the axis of the post, until the point of the auger reaches the centre of the stick. The auger hole should be an inch in diameter, and in telegraph poles of the ordinary size will hold easily four to five ounces of sulphate of copper, which is put into it in the form of coarsely-powdered crystals, and the opening then stopped with a plug, the end of which is left projecting as a handle, so that it can be pulled out and replaced. It is found that the crystals of copper sulphate disappear slowly, so that every three or four months the charge must be renewed; while the wood, both above and below the auger hole, even to the very top of the pole, gradually assumes the greenish tint due to the presence of copper in the pores.

A Rain of Dust.—We take the following from *La Nature*: "On the 3rd of May at Fontainebleau, and again on the 7th of the same month at Cahors, rain fell which brought with it a fine, yellow powder, similar in appearance to flowers of sulphur. It was the *sulphur rain* of the ancients. M. Guilbert, an Engineer officer at Fontainebleau, sent us a sample of the yellow powder collected in that town; it burns with a pungent smell after the manner of organic matter, and leaves grey ashes. A microscopical examination enables us to state that the dust consists of round grains, which are none other than those of the pollen of the *pinus sylvestris*. The pines of the forest of Fontainebleau were in full bloom early in May, and the pollen was carried up by eddies of wind and caught by the rain in the upper regions. At Cahors the neighbouring pines of the Landes explain the phenomenon in a similar manner." Our contemporary adds, needlessly, that these showers of yellow dust, called sulphur rain, are quite distinct from the showers of sand which come from the Sahara and fall in Sicily and Southern Italy.

Electricity in the Royal Navy.—According to the *Electrical Review*, some interesting electrical experiments have recently been carried out by H.M.S. *Bellerophon* in the Mediterranean, with the view of testing the practicability of working the search lights at some distance from the generating source. In one case the projector was fitted on some ramparts ashore, and connected with the *Bellerophon's* electrical plant by means of an armoured cable. A steamboat was then detailed to endeavour to reach the man-of-war without being perceived, but the search lights fixed on shore, and directed from the *Bellerophon* proved so effective, that this feat was rendered impossible, and, in case of actual warfare, the steamboat would have exposed herself to a raking fire from the machine-guns. Other trials tended to show that if a ship could be defended by the electric light in such a manner that the beams surrounded her, it would be, practically speaking, impossible for any craft, however small, to cross those beams without discovery. In such a case the position of the ship would not be so apparent, as when the projectors are fitted on board.

Rainfall in Paris.—In the *Annuaire de la Société Météorologique de France* is an article by M. Hervé-Mangon on the distribution of rainfall and its duration in Paris, based on observations taken during the years 1860-1870. These observations were made with Hervé-Mangon's pluvioscope, and show that rain falls on an average 19 hours a month. The month with the shortest duration of rain was August, which had only 12½ hours, while March had 26 hours, and October and November had a little more than 22 hours each. An examination of the hours of the rainfall during the night and during the day shows that on an average there are fewer hours of rain during the night than during the day. The longest interval without rain was 26 days, from September 11th to October 6th, 1865. The greatest number of consecutive days of rain was 18, from October 3rd to 20th, 1867. The month of March had, on an average, the greatest number of rainy days, viz., 21·2, and the month of June the least, viz., 13·1. The months of greatest and least amount of rainfall do not correspond with these months, the maximum being 2·21 in. in September, and the minimum 1·00 in. in February.

Ozone from Pure Oxygen.—At a recent meeting of the Chemical Society a paper was read on the above subject, by W. A. Shenstone and J. Tudor Cundall. The authors described an apparatus in which oxygen had been prepared and stored without the possibility of air gaining admittance. So far as it was possible to determine the purity of the gas by tests, it would appear certain that it had contained at most only $\frac{1}{5000}$ of nitrogen. The oxygen had been collected and sealed up in glass tubes containing phosphoric oxide, in contact with which it had been kept for periods ranging from eight weeks to eight months. Subsequently it had been submitted to the action of electricity, and the ozone produced had been measured. In one experiment, made at 10 deg. C., no less than 11·7 per cent. of the oxygen taken was converted into ozone. This was a very considerably higher proportion than had been obtained either by Berodie or by the authors from ordinary oxygen when similar means of electrification were employed, but not so high as was obtained by Andrews and Tait. They, however, worked in a different way, and the exact value of their results was uncertain in consequence of the tendency of the sulphuric acid used in their gauges to absorb ozone.

A Safeguard against Insects.—Many people do not know how easily they can protect themselves and their children against the bites of gnats and other insects. Weak carbolic acid sponged on the skin and hair, and in some cases on the clothing, will drive away the whole tribe. A great many children, and not a few adults, are tormented throughout the whole summer by minute enemies. We know persons who are afraid of picnics, and even of their own gardens, on this account. Clothing is an imperfect protection, for we have seen a child whose foot and ankle had been stung through the stocking so seriously that for days she could not wear a leather shoe. All this can be averted, according to our experience, and that we believe of many others, by carbolic acid judiciously used. The safest plan is to keep a saturated solution of the acid. The solution cannot contain more than 6 or 7 per cent., and it may be added to water until the latter smells strongly. This may readily, and with perfect safety, be applied with a sponge. We have no doubt that horses and cattle could be protected in the same way from the flies, which sometimes nearly madden them, and it even seems possible that that terrible scourge, the African Tsetse-fly, might be kept off in the same manner.—*Lancet.*

Pita.—According to a report of Consul Burchard, of Ruatan, in Honduras, the pita plant has never been cultivated, but grows wild in patches on the borders of rivers and lagoons. The stalks of the plant contain the fibre of commerce, and grow sometimes to a height of twelve feet. The Indians scrape off the hard skin of the stalk with a bamboo knife, and thus obtain the fibres which form the heart of the stalk. Another plan is to steep the stalks in water until the skin decomposes; but this is said to injure the fibre somewhat. In recent years machines have been devised to decorticate the fibre, but these have all been failures, owing to the fact that no machine has yet been invented capable of operating on a profitable scale. In Honduras the pita or "silk-grass" fibre is used chiefly for thread, nets, fish-line, and cordage. Samples of the fibre sent to the United States and to Europe have been manufactured into lace, handkerchiefs, ribbons and wigs. It is held to be a substitute for silk or linen; and if proper machinery were forthcoming, the produce of the wild pita fields of Honduras might be used in commerce. Consul Burchard indeed expresses the opinion that the fibre is destined to become a very important element in the future commerce and industry of the country where it is grown.—*Scientific American.*

Instantaneous Photography.—A new pocket camera, which is being brought out under the name of Stirn's patent, is just now creating considerable attention in scientific circles. The instrument is designed for use by amateurs, and consists of a shallow metal box 5½ in. diam., which can be suspended from the neck like a field-glass. Within the box is a sensitised dry plate, which can be revolved from a central knob. The objective is a lens contained in a tube of ⅝ in. diam., placed on the front face of the box near the rim, and does not require to be adjusted for distance. The apparatus is specially valuable for taking photographs secretly, as it can be worn under the coat with only the lens projecting through a button-hole. On the inside of the objective is a slide which can be momentarily opened by pulling a string. We have seen some of the photographs obtained, both in the original size and enlarged twelve to fifteen times. They were exceedingly sharp and well defined. After an impression is taken the sensitised plate is turned through a sixth of a revolution by the knob above mentioned, a pointer indicating the exact position of the plate, which can thus receive six distinct impressions. The apparatus, inclusive of six plates, costs only 30s., and owing to this low price it will probably come into extended use.—*Industries.*

Origin of Alpine Lakes.—At a recent meeting of the Royal Society of Edinburgh, Prof. Geikie read a paper by Prof. Sacco, of the University of Turin, on "The Origin of

Great Alpine Lakes." In this paper the author brought forward a new explanation of the origin of the lake basins of the Alps. He is of opinion that these large troughs are the direct result of that great movement of upheaval which brought the Pliocene period of the Alpine regions to a close. They owe their origin, he thinks, partly to fractures and foldings of the strata, and partly to local subsidences and elevations. Professor Geikie said he could not agree with the author that the post-Pliocene elevation of the Alps and Apennines had produced any notable amount of fracturing and folding. The Pliocene strata occur in approximately horizontal and undisturbed positions along the foot-slopes of the Alps. And there was good evidence to show that the great Alpine valleys were much older than the Pliocene period, during which period they existed as fiords. If the lacustrine troughs, with their irregular depths, were due to earth movements—to fractures, foldings, or local elevations and depressions—there should be abundant evidence of such movements in the geological structure of the ground; but Dr. Sacco had not adduced any evidence of the kind required in support of his views.

Carnivorous Plants.—Attention has lately been called by Herren Kerner and Wettstein, in the Vienna Academy, to two carnivorous plants found in Germany. One of these is the leadwort root (*Lathræa squamaria*), which has no chlorophyll, and passes for a parasite, as it fixes, with small nipples, on the roots of fruit trees. The pale stems, appearing in shady, moist places in spring, are covered thickly with scale-like leaves, each of which has its upper half rolled back on the back of the lower, leaving a hollow space between. Into this open by small holes from five to thirteen separate chambers, having on their surface numerous tufted hairs and hemispherical horns connected with the vascular bundles. Various small animals get into these chambers, and ere long disappear. From both hairs and horns threads of plasma stream out, when the animals come in contact with them, and lay hold of them. Though it is not exactly proved that the plant benefits by the animals it thus catches, this seems very likely from its general character. It is more remarkable that a plant containing chlorophyll, and existing independently, like *Bartsia alpina*, should have similar organs for the capture of animals, and should feed on such, as the authors assert. The plant forms in autumn underground buds covered with scales, whose lateral borders are rolled outwards, making a hollow in which are organs very similar to those in the leadwort root.

Electrical Searches for Bullets.—When President Garfield was slowly dying at Elberon, and the attending surgeons were locating the fatal bullet in spots far from where it was discovered after death, an electrical apparatus was constructed by Professor Graham Bell for the purpose of finding the lead. The failure is known to all, but the discovery has since been made that Garfield lay on a metallic mattress, and that this frustrated the electricity. Under the sanction of the New York Academy of Medicine, another machine has recently been constructed and tested. This machine consisted of a battery, coils, and other familiar devices, but principally of a thin steel probe connected with the wires in a manner invented by Bell. The skin of a patient was cocained over the part where a bullet was supposed to be embedded, so as to deprive the part of feeling. Then the probe was thrust in. As the end of the steel came within six inches of the bullet, the surgeon, with his ear to a telephonic cup, heard a humming sound, which grew louder as the metal was approached, and in this way the position of the bullet was ascertained. Later, a veteran submitted to a search for a bullet which had entered his chest and had remained somewhere in him for twenty years. The needle hummed its way to the hiding-place of the lead, which was then removed. Dr. John H. Girdner, who applied the instrument, said that its use would in all probability have saved President Garfield's life.

The Diatomite in Skye.—In our April number we mentioned the important discovery of diatomite at Loch Quire, in the Island of Skye, one of the Scotch Hebrides, and we are glad to know that operations for using the "find" have been undertaken energetically by the enterprising proprietor. The loch, the bed of which is quite level, and covered with marshy reeds, has already been successfully drained; and a supply of peat has been cut for kiln-drying during the sunless winter. Twelve timber sheds, each 25 feet by 3½ feet, have been erected, and others are being built. In each shed are five drying-pans, one above the other, and the sides are open. Two semi-circular iron stores, 28 feet in diameter, are nearly finished; and two similar stores of double the size are being erected at the seaside. The diatomite is found about 18 inches below the mossy surface, and extends downwards to a depth of 25 feet. It is cut into blocks like peat, with a common peat spade, and is carried on hand barrows to the drying sheds, where it is left till it is dry. It is afterwards put into the local stores until it is removed to the seaside stores. The tramway of three miles has not yet been laid, and the diatomite is being conveyed down to the shore on horseback. When cut it has a greenish appearance; but on being dried, it assumes a bright white colour. There seems to be an inexhaustible supply of the valuable deposit in an exceptionally pure state. Other works are to be erected at Loch Callum-kill, but the diatomite is not so pure as at Loch Quire; still, if it does not serve for ultramarine paint, it can be used in the manufacture of dynamite.

The Landslip at Zug.—From *Industries* we learn that the catastrophe which has recently happened to the town of Zug was not quite unexpected, although nobody supposed the danger so near. When building the new embankment three years ago, the town authorities consulted Professor Heim and Herr Moser, of Zurich, about some slight settlements of the works which had taken place during the construction. The report which was then made by these gentlemen bears so directly upon the present case, that a short abstract of it will doubtless be of interest to our readers. It was explained that the greater portion of the town is built upon the delta containing the detritus of the different brooks and rivulets falling into the Lake of Zug at that place. It is well known that at the mouth of every water-course the sediment of the particles carried down in suspension takes place by degrees, the heavier particles being deposited immediately, but the lighter particles being carried further out. Since the angle of repose for detritus under water is less than when it is in a dry condition, the upper and coarser layers, after they reach a certain height, have a tendency to slip down into deeper water, where the finer mud has been deposited. It may thus happen that below an apparently solid stratum of gravel there is a considerable thickness of fine mud, and, from soundings taken in the soil on which the town stands, this has been found to be the case in Zug. The sections representing the configuration of the bottom of the lake near the quay show very clearly the appearance of ground on which landslips have taken place, and it was pointed out that special precautions would be necessary to prevent a slip of the material on this muddy and treacherous soil. This report, it will be seen, explains very clearly the reason of the recent disaster.

## DOMESTIC SANITATION.

No. 4.—Sewage Treatment.

If the refuse fluids or semi-fluids, domestic or industrial, of our towns are not to be run into the rivers, how are they to be safely or, if possible, usefully disposed of? Let us bear in mind that, contrary to a delusion which was at one time fashionable, sewage, though containing such a vast quantity of useful matter, is not a mine of wealth. Municipalities connot expect to meet with a company or a contractor who will not merely guarantee them against all complaints or actions for nuisance, but will pay them a good round sum for the privilege of so doing. The plant-food contained in sewage is so largely diluted with water and so much mixed up with worthless matter—such as road-silt—that a great part of its commercial value is eaten up by labour, carriage, and the general expenses of "handling" a vast bulk of matter. If to extract 20s. worth of ammonia and phosphoric acid from the sewage, it costs us 19s. in materials, plant, and labour, capital will naturally seek out some better investment. But seeing that we are bound, for the sake of public health, to purify the sewage, we may, or rather we should extract from it as much valuable matter as possible, so as to recoup ourselves, in part at least, for the expense of purification.

And here we must utter a reminder often overlooked; town councils and local boards and individual ratepayers very naturally count the cost of sanitary reform. But do they ever ask what it will cost not to do it, to let nuisances continue and increase? We are sometimes told that our population is even at present redundant, and that sanitary improvements will prove a poor investment if they increase the number of persons vainly seeking employment. But what sanitary reformers aim at is a more vigorous, not a more numerous population. Diseased persons, especially the consumptive and the scrofulous, have often more numerous families than those in robust health. This, however, is a subject upon which we cannot here enter.

When it became evident that our rivers could no longer be used as general sewers, either with any regard to health or to the very existence of certain important manufactures, a crowd of strange devices sprang up. More than one inventor has proposed to pump the sewage into barges and convey it away to the sea. Not a few specially contrived vessels for this strange purpose have been duly patented. We think that a very simple calculation will enable us to sweep aside at once all these projects. The sewage, say of Leeds, amounts in fair weather to about twelve million gallons daily, although in heavy rain this amount may be nearly doubled; and as twelve million gallons of water weigh no less than 53,570 tons, to convey this burden away there would be required a fleet of 200 barges, each carrying 250 tons. If the first barge was not able to reach the sea and unload by the time the last of the 200 was full, a greater number would be required. What, then, would be the expense of building, maintaining, and working such a fleet—an expense incurred in pure loss, since there would not be the slightest set-off?

We are not aware that this scheme has ever been tried in practice.

A much more plausible arrangement has been actually carried out by the Metropolitan Board of Works, and even the stern logic of facts can scarcely convince the official mind of its failure. Two huge underground reservoirs were constructed, one at Cross Ness and the other at Barking Creek. In these the sewage of the south and north sides of the metropolis respectively was to be let accumulate, while the flood tide was running up and during slack water. As soon as the ebb began the reservoirs were let flow out, the theory being that before the flood tide returned all the sewage with its abominations would be carried down to sea; or that at least no sewage matter would ever be found above the outlets from the two reservoirs. This theory did not, however, hold good; after a very prolonged trial it was found that the sewage worked up far above the outlets, whilst the lower reaches of the river had become very offensive to the inhabitants of their banks, as well as to the crews of vessels. That there was not the slightest return for the heavy outlay incurred is a matter of course. Hence we can only entertain the hope that no other community will allow itself to be committed to the adoption of this or of any similar scheme.

The only satisfactory principle of sewage treatment rests on a fact which has been observed ages ago. Arable soils, clay, and most kinds of carbonaceous substances powerfully absorb and retain offensive matter, whether presented to them in a dry or in a liquid state, and convert it, with the aid of air and water, into plant-food. We avail ourselves of this fact when we bury animal offal, blood, fæcal matters, etc., in the earth, or when we thrust into the soil the blades of knives, etc., which have contracted the smell of onions or of fish. In all these cases we find the smell quickly disappear. Or if we fill a flower-pot with ordinary garden-soil, and pour upon it a little soap-suds, urine, or blood, or a mixture of all three, we find a liquid draining out below which is colourless, inodorous, and which on chemical analysis is found freed to a very great extent from animal matter.

Upon this one principle—according to the different manner in which it is applied—rest the two main systems of sewage-treatment. These systems have been erroneously thought antagonistic, but in a work which we had the advantage of perusing in manuscript, and which we learn is about to be published, it is shown that they differ merely in a point of detail. It is plain that if we have a polluted liquid to purify, we may either distribute it over a sufficient extent of soil or we may invert the process and diffuse a suitable kind of earthy matter through the polluted liquid. If we take the former method, the process is called *irrigation*, but if we adopt the second it is known as *precipitation* because after or along with the earth we add to the sewage certain substances which cause the particles of earth, thus saturated with the excrementitious matter, to subside to the bottom. In both these methods, if properly performed, the nuisance and danger arising from sewage are got rid of, and in both a great part at least of the manurial matter is turned to its natural account in the growth of crops. Which of the two methods should be actually adopted must depend on local conditions, soils, season, climate, questions of level, etc. At least we think that no man of sound judgment and sufficient experience would at once recommend either method for universal and unqualified adoption.

It is self-evident that in such a season as the present, and still more in countries where persistent drought is of frequent occurrence, sewage irrigation would be a priceless boon to numbers of farmers, as manuring and watering the land simultaneously. It is equally evident that in wet, drizzly seasons like 1879, where the difficulty is how to get rid of the rain fast enough, sewage irrigation would only heighten the mischief, and every agriculturalist would wish to add manures in the dry state.

It is generally admitted that it is possible, by means of irrigation, to purify sewage so that it shall be fit, not, indeed, for drinking, but at least for turning into rivers, for sprinkling roads, and, where engineering difficulties do not interfere, for flushing. It must also be conceded that sewage irrigation may be of great benefit to the land. But, as commonly managed, it is difficult to combine these two objects. The sewage flows from the town summer and winter, and is most abundant in wet weather, when it is least needed, and it must be purified. The farmer wants it only at certain times of the year, in certain kinds of weather, and for certain crops. Hence it is necessary that the sewage should be distributed, or be at least capable of distribution over a very large area, so that some portion of the land may be always in a condition to receive the stream. Ordinary prudence would stipulate that the sewage should be turned off from any field or market garden for a fortnight before the herbage is cut for the use of cattle, or before vegetables and fruits—especially those which are commonly eaten raw, such as lettuce, celery, strawberries—in order that full time may be given for any fæcal matter to be assimilated by the plants. Night-soil has long been used without unpleasant consequences for manuring fields and gardens; but it was generally applied in the late autumn or winter, and was not brought into close proximity to vegetables immediately before they were gathered. It will be remembered that during the last visitation of cholera at Paris, the inhabitants were warned by the sanitary authority against consuming the produce of the celebrated irrigation fields of Gennevilliers.

In our next issue we shall consider the drawbacks to be combated in the treatment of sewage by precipitation.

(*To be continued.*)

## The RED COLOURING MATTER of BLOOD.

ALL the animals most familiar to us, such as quadrupeds, birds, and fishes, contain red blood. Quadrupeds and birds are so charged with this red fluid that it pours out copiously when they are wounded, and their flesh is red, *i.e.*, deeply stained with the colouring matter of blood. The greatest quantity of blood found in any animals of their size is met with in seals and other diving quadrupeds, which are very troublesome to the dissector on this account. If the body of a fish is opened, a very different state of things is found. The blood is scanty, and only flows freely from a few large vessels, while the muscles, as a rule, are pale or white. A fish, we may remark, is usually poorly nourished in comparison with a quadruped, and rarely contains any fat. We see, then, that in quadrupeds, which are ordinarily active and well-fed, as well as highly organised, much red blood is found; and that this is especially the case with those quadrupeds whose mode of life is liable to interfere with free and regular respiration. On the other hand, fishes, which are the lowest and worst-provided of vertebrate animals, contain little blood. A few fishes, however, *e.g.*, the salmon and sturgeon, which have exceptional opportunities of growing fat, get a tinge of red in their muscles—an indication of the comparative abundance of their blood.

Why is blood red? We can only answer the question partially by saying that blood contains a red substance upon which its usefulness almost entirely depends. Blood has two functions—nutrition and respiration; and these are closely connected, as is shown by the fact that venous blood, which has given up its oxygen, has absolutely no nutrient value. The respiratory office of the blood is discharged by a red substance (hæmoglobin), which is contained in a state of solution by the red corpuscles. Hæmoglobin is a crystalline body, the crystals being easily procured from the blood of some animals (horse, cat, dog, rat, etc.), but with difficulty from others (man, ox, sheep, rabbit, etc.). The physiological use of hæmoglobin turns upon the singular facility with which it absorbs oxygen, and the equal facility with which it gives it up to any tissues poorer in oxygen than itself. Hæmoglobin is like a sponge, absorbing greedily, but parting at the slightest squeeze with what it has absorbed. It is possible to separate hæmoglobin into a proteid constituent and a brownish-red substance, which sometimes shows a metallic lustre (hæmatin). An alkaline solution of hæmatin is prone to take up oxygen and to part with it again; so that it is probably in the hæmatin that the oxygen-carrying power of hæmoglobin or of red blood resides. Hæmatin contains the elements usual in animal compounds, viz., carbon, hydrogen, oxygen, and nitrogen, but to these is added a trace of iron. Inconsiderable though the iron is in quantity, it is of essential importance; for if it be removed by acids, the hæmatin at once loses its oxygen-carrying power.

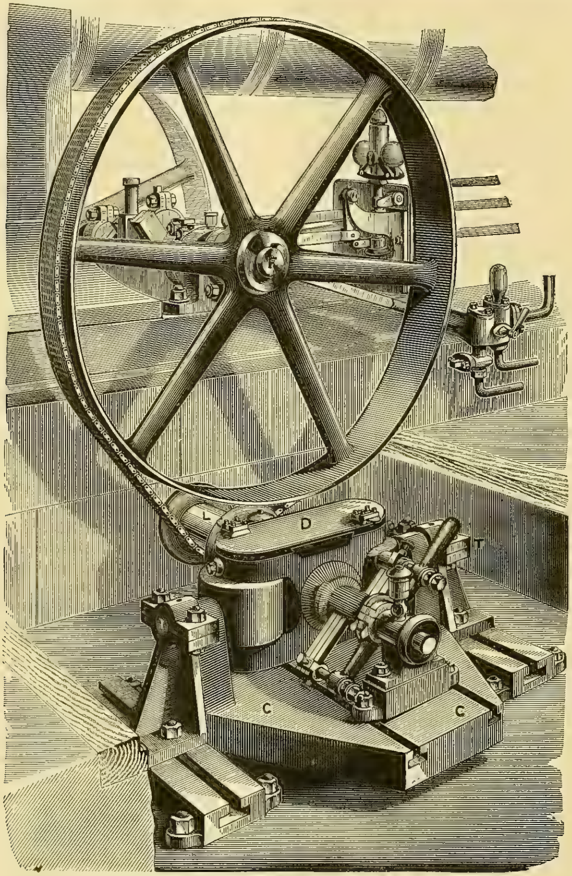
Though hæmoglobin is very general in vertebrates, it is not quite universally present in them. The little fish, amphioxus, and not a few of the pelagic fish-larvæ known as leptocephali, are destitute of hæmoglobin, and consequently of red blood. All these are transparent fishes, distinguished by the almost gelatinous texture of their tissues and the delicacy of their skin.

Invertebrate animals, such as snails, worms, and the like, seldom contain red blood. They often, it is true, contain a fluid which circulates like blood, and has something of the same microscopic appearance; but invertebrate blood, as a rule, is either colourless or tinged with some other colour than red. Now and then, however, even invertebrate animals are found to possess true red blood, containing hæmoglobin. Most of the examples are met with among the worms. The common earthworm, the leech, the little red worm (tubifex) found in muddy pools, the lobworm found on sandy shores, and the nemertine worms, which wind in and out of the mud and stones in shallow seas, are among the most familiar. It is noticeable that a great proportion are burrowing animals, and this is pretty commonly the case with other invertebrates which contain red blood. Mollusks are nearly always destitute of hæmoglobin, but the burrowing razor-fish (Solen legumen) is an exception. Insects, too, follow the same rule; indeed there is but a single exception among them. The "blood-worm," or the burrowing and aquatic larva of a dipterous fly (chironomus), contains hæmoglobin in its blood, which altogether disappears when the insect begins to breathe air. The common house-fly contains a red substance in its body, but this is not hæmoglobin, as the spectroscope shows. Lastly, there are two or three freshwater crustacea which possess hæmoglobin. It is significant that so large a proportion of the red-blooded invertebrates should be burrowing animals, and we can readily see that they require an oxygen-carrier all the more because they can aerate their blood only at a small part of the surface of the body. The same principle seems to govern the distribution of hæmoglobin in vertebrates, though here the proportions of the species with and without hæmoglobin are reversed. Vertebrates are very generally thick-skinned animals, of large size, breathing by definite respiratory organs, and consuming much oxygen in consequence of their activity and rapid metabolism. The very few which have not red blood are of small size and low grade, and have a skin so thin and absorbent as to allow the exchange of gases through it.

Tolerably complete lists of the animals with and without hæmoglobin seem to point almost inevitably to some such explanation as we have attempted to give, but we are far from claiming that the subject is cleared up. For instance, we have pointed out that a large proportion of the invertebrates with hæmoglobin are burrowing animals, but if anyone should ask why do not all invertebrates which burrow possess hæmoglobin, we must admit that the question is too hard for us. Failure to answer it does not, however, necessarily overthrow the explanation. We may affirm that the reason why some people wear wigs is that they have lost their natural hair, and this account of the matter would not be disproved by any number of cases of bald men who don't wear wigs.

Other pigments besides hæmoglobin occur in the bodies of animals, and some of these appear to have a respiratory function, *e.g.*, the blue pigment found in some mollusks, and the purple pigment of bugula and some sponges. Kuhlmann has shown that cochineal solutions have some power of taking up oxygen and parting with it again, and that they deepen or pale in colour in consequence. It may turn out that both cochineal and the very similar lac-dye serve as respiratory pigments to the insects which form them, but it is useless to speculate upon facts which are as yet imperfectly ascertained.

To readers of a practical turn of mind the great economic value of cochineal, the abundant supply of hæmoglobin, and those resemblances between cochineal and hæmoglobin which have already engaged the attention of chemists, will perhaps suggest that hæmoglobin may some day be put to industrial use. The indications are not very decided as yet, and it is pretty safe to venture the opinion that the interest of hæmoglobin will long continue to turn exclusively upon its physiological office.



Dynamo Electric Machine driven with a Short Belt.

## DRIVING DYNAMOS WITH SHORT BELTS.

PROFESSORS AYRTON and PERRY recently read a paper on the above subject at a meeting of the Society of Telegraph Engineers and Electricians, and as many of our readers are interested in the driving of dynamos for electric lighting, we give an illustration, which will enable them to understand clearly what is now proposed. We are all familiar with the horizontal belting generally used, but such an arrangement is almost impossible on board ship, or wherever the space available is confined, and a short belt would always be employed were it not that the small angle of contact of the belt with the driven pulley would then necessitate the tension on the belt being excessively great, to ensure sufficient grip for driving. The increased tension would cause excessive pressure on the bearings, and this would not only involve waste of power, but also frequent stretching of the belt and increased wear.

In our illustration, D is the dynamo, L its driven pulley, and F, the driving pulley, or fly-wheel of an engine. The fixing of the dynamo is peculiar, and on this depends the efficiency of the system now under notice. Instead of being fixed rigidly in the usual way, the dynamo is attached to a cradle, C, and this in turn is swung loosely on the trunnions, T, T, the dynamo being placed in such a position that it and the cradle just balance when the dynamo pulley is removed. This pulley is heavier than an ordinary dynamo pulley, and when keyed on, its weight gives the necessary tension to the driving belt without causing excessive strains on the bearings. Very smooth driving is thus obtained, with a comparatively low tension on the belt and with little strain on the spindle.

The arrangement is certainly an ingenious one, and we are glad to hear from Professor Ayrton that it has been tried for some time in a practical way for a portion of the electric lighting at the Central Institute, and that it has answered very satisfactorily. Among other advantages, it is pointed out that with this system the rim of the fly-wheel need not be specially turned, the axes of rotation of the armature and fly-wheel need not be accurately parallel, and the cradle of the dynamo being low down it can easily be made steady. Rope bands can be used instead of leather belting.

## THE TELEPHONE: ITS PRINCIPLES, CONSTRUCTION, & APPLICATION.—I.

THE purpose of this paper is to give some description of the telephone from a scientific and practical rather than from a historical point of view. The history of its invention and development is an interesting one, but it bristles with controversial points, and questions of priority of invention, patent rights, and other thorny topics with which we do not wish to deal here. Therefore, when names of inventors, or dates of inventions are given, they must be taken to indicate simply the persons who introduced the facts to public notice, and the dates at which the facts became known to the scientific public.

To understand the principles and action of the telephone, something must first be known about the laws and nature of sound, and something about the laws of electricity.

In the first place, it is necessary to remember what sound is before its transmission can be understood. Sound, as known to us, is the result of vibrations or waves falling upon a special organ of sense. Some people, perhaps, have never troubled themselves to consider what kind of vibrations or waves sound is caused by. They think vaguely of the waves of the sea, and imagine that waves of some similar kind are formed in the air, or any other medium conveying sound.

These waves or vibrations are simply alternations of high and low pressure in the medium, starting from the source of the sound, and spreading out in a spherical form from that source as a centre, provided that there are no obstacles or reflecting surfaces to deflect or reflect the waves. The old illustration of a stone thrown into a pond is about the best that can be offered, and the widening circles of crests and troughs, as shown in Fig. 1, may be looked upon as a picture, a sectional view so to speak, of the condition of air or any other medium surrounding any source of sound, the crests of the waves being taken to represent compression, and the troughs to represent dilatation of the medium. These waves of pressure acting upon a little circular membrane, the drum or tympanic membrane of the ear, are transmitted to the delicate nervous apparatus of the internal inner ear, and so produce the sensations of sound. Those who wish to go into this very interesting and beautiful subject of wave-motion should read Dr. Tyndall's book on "Sound and Light."

The next point to notice is that all the varying sounds which assail our ears are distinguished simply by two characters; firstly, the frequency of the vibrations; secondly, the shape or outline of the waves. Frequency of vibration determines pitch. The shape of the waves determines character, quality, or *timbre* of the sound. Sounds which are devoid of definite rate of vibration may be classed as noises, while sounds which have a definite vibration-rate may be classed as musical, this definition being of course a scientific, not an artistic one. If two sources of sound act simultaneously upon any medium, the resultant sound is simply that due to the superposition of the two sets of waves. It may be possible to pick out both sounds, one may predominate, and the other only affect its timbre or character, or they may be so blended as to produce the impression of one sound only. The subject is a tempting one, but must not lead us astray from that which we are considering. Enough has been said to show that all sounds are simply due to successive waves of high and low pressure in the medium of their propagation. The succession of waves may be regular or irregular, the waves may be rough or smooth in outline, and every

Fig. 1.—Illustrating Sound Waves.

difference in either character produces a difference in the sound. It is further to be noted that difference in loudness is due simply to difference of amplitude of the waves, or in other words to the amount of the differences in the pressures at the crest and in the trough of the wave.

From this it may be easily seen that to produce any sound of a given character and pitch, it is only necessary to give the medium of propagation a succession of impulses at some particular rate, and in some particular order, as regards their relative amount. If the medium is air, or any other fluid, this can be done by causing some flat surface to vibrate in the medium in a manner, as to frequency and other points, corresponding to the sound vibrations required. It will also be obvious that any flat surface exposed to air vibrations, and free to move in any way, may be set into vibrations corresponding to those of the air. As a matter of fact, however, scarcely any solid body, of any shape, is at liberty to vibrate in all ways. Nearly everything, even a body of air in a tube or other vessel, has a strong tendency to vibrate at some particular rate, or rates, and in some particular way, and will only respond freely to vibrations similar in pitch to those which it tends to produce if struck or otherwise agitated.

There is one shape which has practically no tendency to vibrate to a particular sound or sounds; it is equally ready to take up all kinds of vibrations, and is the exact form of that diaphragm or tympanic membrane of the human ear previously mentioned, viz., a disc fixed round its circumference or edge; free everywhere else, but stretched and flat. When such a disc is exposed to aerial vibrations, it takes up the vibrations in the form of excursions to and fro, which are greatest at its centre and smallest at its edge.

It can be understood, then, that when such a disc is exposed to a succession of varying sounds, such as a musical air, or to spoken words, its vibrations change in conformity with the changes in the sound waves, and correspond to them.

It would not be strictly accurate to say that a diaphragm has no vibration period of its own, or that it responds with equal readiness to all kinds and rates of vibration, but practically its defects may be disregarded in considering the main action. It may be further noted that a circular shape is not essential to the practical working of a telephonic diaphragm, though it is probably the best form.

Now, then, the problem of telephony, or the transmission of sound to a distance, may be stated as the problem of causing a diaphragm performing vibrations at one place, to produce similar motions in a distant diaphragm. It has to be remembered that the vibrations are extremely small in amount and extremely rapid, and that they represent a very small amount of energy; also that failure to transmit very slight changes in the rates and characters of the vibrations means failure to reproduce exactly the niceties of articulation, and consequently produces indistinct or unintelligible speaking.

This being the case, it follows that our medium of transmission must be, so to speak, very free from friction and inertia, because friction means dissipation of some of the originally small amount of energy, and inertia means failure to respond to the small changes in the vibrations. The first medium that suggests itself is a mechanical one. If two diaphragms are connected in the centre by a rod, wire, or string, it seems natural that motions communicated to one will be transmitted to the other. This is so, and most people have seen and used the old "lovers' telephone," of which perhaps the simplest form is two lobster or condensed milk tins, each with a hole punched in the centre of the bottom, and a string knotted inside each and stretched between them. Such mechanical telephones answer fairly well for short distances, but the friction of the supports, and the inertia and extensibility of the wire or string, render the mechanical telephone useless over distances much exceeding half a mile, even when straight runs can be obtained.

Twenty-six years ago, Farrar, and three years later Bourseul, suggested that electricity might conceivably be used for the transmission of sound and speech. Reis, in 1861, set himself the task of experimentally proving this possibility. He went about the work in the most scientific way, studying the construction of the human ear, and endeavouring to adapt in his instruments the lessons learnt from it. Reis made instruments which actually transmitted sound, and a receiver which was quite capable of reproducing speech. The weak point was the transmitter. There can be little or no doubt, that with sufficiently careful adjustment, his transmitter could, and did, transmit speech. However that may be, his labours had no immediate practical or commercial result. Had Reis been able to inspire a capitalist with some faith and imagination, the telephone industry might to-day be one of twenty-five years' standing. But this is touching on thorny ground, which we must avoid, as these remarks are not written with a controversial aim. The telephone as a commercial and practical instrument is associated with the name of Graham Bell, who, in 1876, invented the instrument, which, in one form or another, is the most widely used telephone receiver of the present day. It has the remarkable property of being available either as transmitter or receiver, and it is this feature which constitutes its chief beauty, scientifically speaking, although practically, it is very little used as a transmitter.

Before this instrument is described, it is necessary to give a brief account of the electrical laws upon which its action is based, for we have to see how the transmitter receiving sound waves, produces, or varies, an electric current in the conducting line and the distant receiver, and how that varying current reproduces in the receiving diaphragm vibrations similar to those performed by the sending diaphragm. The electrical laws involved are those expressing certain relations between electric currents and magnets, or magnetic fields (a magnetic field is the space in which a magnet or an electrical current has a magnetic influence).

Briefly put, these laws may be thus stated :—

1st. An electric current can be set up in any electrical circuit, by any change in the strength or direction of the magnetic field in which any part of the circuit happens to lie, provided that such change has the effect of causing a larger or smaller number of "magnetic lines of force" to be included in the circuit. The current will continue while

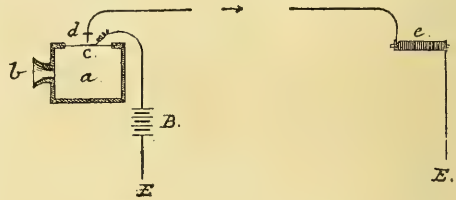



Fig. 2.—Reis's Telephone.

the change takes place, and will be stronger or weaker, in exact proportion to the rate of the change, while its direction will depend upon the nature of the change, *i.e.*, currents in reverse directions will be produced by increasing and decreasing the number of lines of force included in the circuit.

2nd. An electrical conductor carrying a current produces a magnetic field in its neighbourhood, and a piece of iron or steel placed near the conductor will be magnetised in a direction at right angles to the conductor. The magnetisation will be (approximately) proportional to the strength of the current, and its direction will depend upon the direction of the current.

The Bell telephone, shown in section in figure 3, contains a steel magnet, A; a coil of insulated copper wire, B, wound on a bobbin for convenience, and surrounding one end of the magnet; and a diaphragm, or disc of thin sheet iron, C. All these parts are fitted into a case of wood, or similar material, forming a handle and mouthpiece. It will be observed that the iron disc, C, is clamped round its edge by the wooden mouthpiece, that it is mounted at right angles to the length of the magnet, and that its centre is close to the end of the magnet which carries the coil of wire.

The coil of wire forms part of an electrically conducting circuit, the remainder of which consists of two-line wires, or one-line wire and the earth, and the coil in the distant instrument, which is exactly like the one described.

Every one who has played with a penny magnet will see that the magnet A must be attracting the centre of the diaphragm C, and also that any variation in the strength of that magnet will either bring C nearer to, or allow it to spring farther from A. Now the wire in the coil B is all at right angles to A, and by our second law, any current passing in it will tend to magnetise A in one direction or the other, according to the current's direction. If the tendency is to magnetise A in the same way as its permanent magnetism, it will be strengthened; if the tendency is to reverse its magnetism, it will be weakened. Then, if we can produce a current in the coil which shall change its direction and strength in a way corresponding to the shape and frequency of certain sound waves, we shall cause the diaphragm C to perform vibrations correspondingly, and it will give forth to the surrounding air the sound desired. But how is this vibratory current to be produced in the coil? Here our first law comes in. The coil B is in a magnetic field of a certain strength, *i.e.*, a certain number of magnetic lines of force pass through it. If the diaphragm C approaches the magnet A, the number of lines of force passing through B is increased; if C recedes from A, the number of lines passing through B is diminished. In either case an electrical current is set up in B, and in the whole circuit (including the coil of the distant instrument), of which it forms part, but the currents will be in reverse directions in the two cases. If this chain of statements is borne in mind, it will be immediately obvious that any vibrations im-

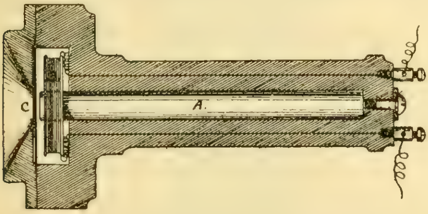



Fig. 3.—Section of Graham Bell's Telephone.

parted to the transmitting diaphragm from the air, will set up vibratory electrical currents in the electrical circuit which includes the coils of both instruments, and that the current vibrations will correspond to the sound vibrations in force and direction. Here, then, is the vibratory current which we have just shown to be capable of causing the receiving diaphragm to produce sound. Put the two actions together, and the transmission of speech by two Bell's telephones, one acting as a transmitter at one end of the line, and the other as a receiver at the other, is explained.

It will be seen that no battery or other external source of current is used with the Bell instruments. The whole of the energy is supplied by the original air vibrations; the faint but clear whisper which issues from the receiver is in very truth produced by the exertion of the person speaking to the transmitter. Few prettier examples of the transformation of energy can be given than the one just described, which may be thus tabulated—

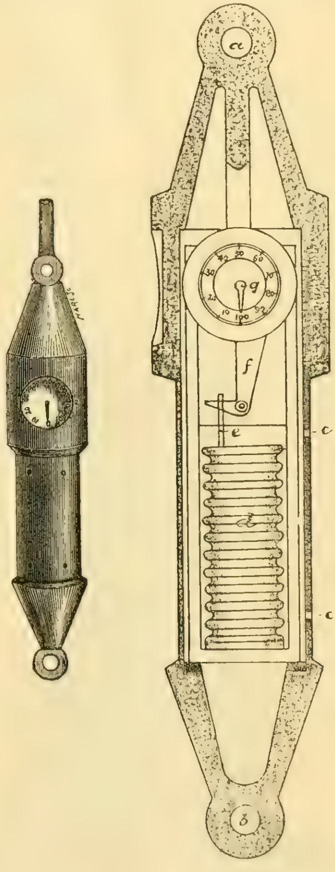
*Mechanical Energy:—*
Air vibrations transformed to diaphragm vibrations—
*Electrical Energy:—*
Transformed to vibratory change in a magnetic field—
Transformed to vibratory current—
Transformed to vibratory change in magnetic field, causing vibratory attraction—
*Mechanical Energy:—*
Transformed to vibratory motion of diaphragm—
And back to air vibrations.

A complete cycle of changes of form, yet, all through, the one characteristic—the vibratory feature—is maintained.

(*To be continued.*)

## BATHYMETER, OR SOUNDING APPARATUS.

In our March number we described an apparatus used for deep-sea sounding, and we now illustrate a much smaller and less complicated apparatus, used chiefly for taking flying soundings, without stopping the ship or altering her speed. This instrument is called by its makers the Bathymeter (from *βαθος bottom* and *μετρον measure*), and its action depends on the pressure of the water overlying




Apparatus for taking Flying Soundings at Sea.

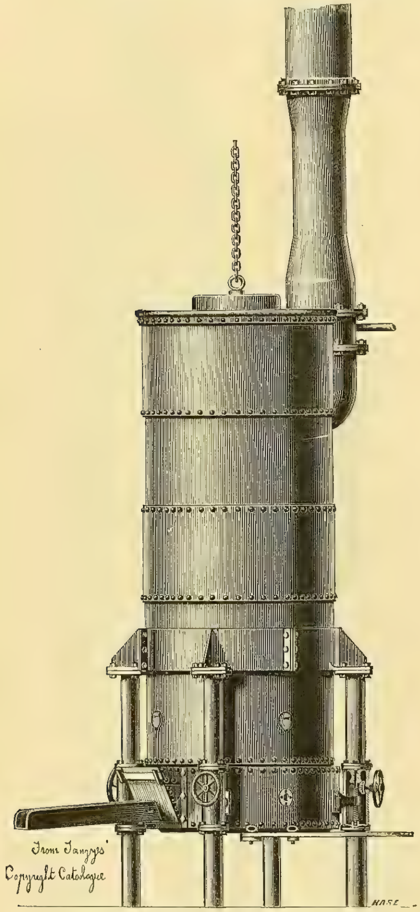
it when it is hove overboard, as will be presently described. Fig. 1 represents an external view, and Fig. 2, a vertical section. The sounding-line is a thin wire cord of great tensile strength, made of phosphor-bronze to prevent rust or corrosion. This line is fastened to the eye *a*, and at the other end a sinker is attached to the eye *b*. Small holes *c c* are provided in the outer casing, and through these the water passes to the interior, and there presses on a hollow corrugated tube *d*, hermetically sealed. On the top of this tube there is a catch *e*, acting on a lever *f*, and this in turn works the needle or pointer *g*, on the dial face.

When the bathymeter is lowered in the water there is a greater pressure on the outside of the tube *d* than within, consequently it is somewhat compressed, and the extent of its compression is registered on the dial. From this it will be understood that its readings do not depend on the length of line paid out, but on the pressure produced by the vertical height of the overlying water. It is quite immaterial what position the instrument may assume in the water, and the depth registered in no way depends on the direction it follows in going to the bottom. The figures on the dial represent the pressures produced by varying depths of water in fathoms, so that readings can be taken direct without any calculation. There is also a spring-catch to retain the pointer in place, until the instrument is taken out of the water and examined. After the examination the catch is released and the pointer returns to zero, the sounder being then ready for another cast.

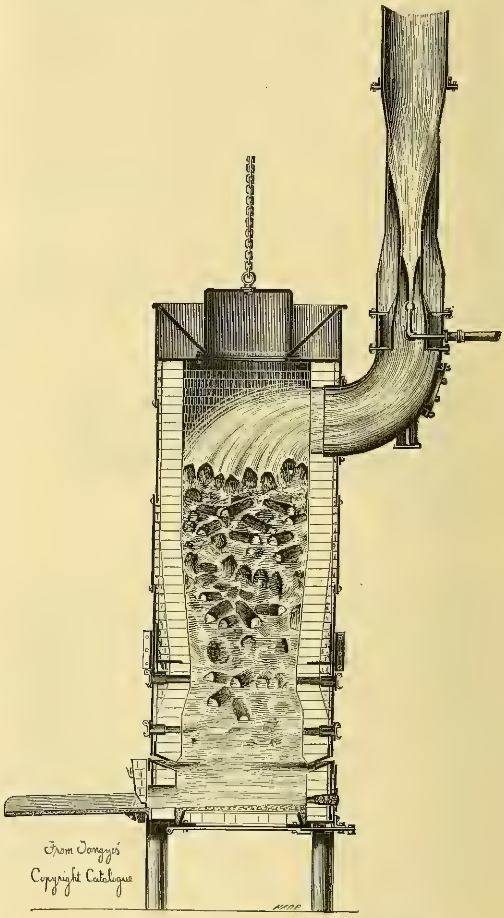
All the working parts of the apparatus are plated, to protect them from the action of the sea-water, and they are enclosed in a brass case, having a sliding cover for inspection of the dial when required. The apparatus has many good and useful points, and we have much pleasure in recommending it. The makers are The Hannay's Patents Company, Limited, of 67, Great Clyde Street, Glasgow.

## THE HERBERTZ CUPOLA.

OUR readers are doubtless aware that the iron used for making castings in a foundry is mixed with coke and melted in a cylindrical furnace, called a cupola. For the operation to be successful there must be a strong indraught of air to quicken the combustion of the coke, so as to intensify the heat and liquefy the metal. For this purpose it is usual to obtain an air blast by means of a rotary fan, driven at a high speed by engine power, but a new system has lately been adopted which promises very important results. The new cupola was invented by Mr. Herbertz, and is now being made in this country by Messrs. Tangye,



THE HERBERTZ FOUNDRY CUPOLA (ELEVATION.)



THE HERBERTZ FOUNDRY CUPOLA (SECTION.)

of Birmingham, to whom we are indebted for the accompanying illustrations. The leading feature of this cupola is that the indraught of air is produced by the sucking or inductive action of a jet of steam fixed near the base of the chimney. In this way the waste gases are drawn out of the cupola, and air is drawn in, with complete uniformity, and without any engine or blower being necessary. Messrs. Tangye state that they carefully examined cupolas of this description in Germany and Switzerland, and then erected one at their own works, capable of melting three and a half tons per hour. This is now working regularly, and with it they find that the consumption of coke is only seven per cent. of the weight of iron melted, and as twelve to sixteen per cent. are required in the cupolas ordinarily used, the saving in fuel may be said to be about fifty per cent. This fact alone shows the importance of the invention, but in addition to this, it is stated that the quality of the iron is improved. We also learn that the new cupola has been used for smelting lead, for burning lime, and for manufacturing sugar—all with good results.

## THE SPECTRUM.—III.

THE analogy between sound and light affords an explanation of the Fraunhofer lines which were described in the last chapter. If we raise the damper from the strings of a piano, by holding down the loud pedal, and sing Ah on any note, certain strings will respond. These strings are those which, when vibrating, give the notes of which the Ah is composed, for it must be remembered that hardly any musical sounds are simple, but are made up of the principal note and its harmonics, which vibrate twice, three times, four or more times faster. The vibrations of the air set the strings in motion, and in so doing, expend part of their energy on them. It is thus conceivable that a screen of tuned strings might be able to stop the passage of certain notes, by absorbing or taking up their vibrations, but it would allow other notes to pass if their period of vibration did not correspond.

The molecules or ultimate particles of different substances are associated in some way with certain rates of vibration; the connection, however, has not yet been discovered. It is not unlikely that it may be found to have some bearing on the science of crystallography, which up to the present is merely the plaything of a few mathematicians, and the bugbear of most geologists. As with sound, it is rare that the vibration is simple, but on the other hand, the different periods or vibration-frequencies of the Fraunhofer lines do not as a rule bear any mathematical relation to each other.

If the spectrum of pure white light, as from an electric lamp or from lime-light, be observed after passing through the vapour of the metal sodium, or of common salt, which is the chloride of that metal, the remarkable double Fraunhofer line called D will appear, just as it does in the solar spectrum. The molecules of sodium vibrate about 508,905,000,000,000 to 509,430,000,000,000 times a second, and take up the vibrations of this frequency, just as the strings of the piano take up the note sounded near them. The lines appear quite black compared with the rest of the spectrum, but they may give out a faint light, just as the strings which have stopped the sound will give out a faint note by the vibrations set up in them.

If now we raise a piece of sodium, or rather its vapour (for it is easily volatilized), to so high a temperature that it glows, and observe the light with a spectroscope, instead of a continuous spectrum, only a brilliant double line will be seen, and this will be the D line reversed. With a good spectroscope, a few other faint lines will also be seen.

We now come to the important fact on which the whole method of Spectrum Analysis is founded, and to which all the foregoing account of the spectrum and description of the instruments has been leading up, namely, that each line is a *certain indication* of the presence of a particular substance. Thus the D line, whether observed as a dark or as a bright line, is the positive proof of the presence of sodium, and not only this, but one 200,000,000th of a grain is enough to give the line. Further than this, no mistake or uncertainty is possible under any condition or circumstances that we know, or can conceive. No other substance gives lines which bear any resemblance, and by a method of comparison, which will be described, there is no room for doubt, even when a very complicated set of lines is being examined.

If instead of sodium, phosphorus is burned, two lines in the green and one in the greenish blue are seen, besides a few others of less importance. The spectrum of iron has about 1120 lines, some of which are extremely fine, and others very conspicuous; amongst the latter are three which correspond with the solar lines E, G, $H_1$, and $H_2$. These lines have been measured with great care, and the wave length of each is known and registered.

In the illustrations of the different spectroscopes given in the last number, a small prism may be seen just in front of the slit. This is for the purpose of reflecting the light from another source, so that two spectra can be compared, the one being immediately below the other, and in this way the lines can be accurately identified.

By this means it has been found that the sun is surrounded by the vapours of sodium, calcium, barium, magnesium, iron, chromium, nickel, copper, zinc, strontium, cadmium, cobalt, manganese, aluminium, titanium, and vast quantities of hydrogen. The lines of the sun's spectrum not only correspond in position but in relative strength and character with the lines of these substances as they exist with us, some lines being sharp and distinct, and others ill-defined and hazy. Some of the metals named, such as copper and zinc, appear to be present in the sun's atmosphere in comparatively small quantities, since only their more prominent lines are found; while gold, silver, lead, arsenic, mercury, antimony, and some fourteen other rarer elements, do not seem to be present at all.

Such great confidence can be placed in the conclusions which are drawn from observations of the spectrum, because the records are quantitative, and not merely qualitative. If it were merely that a certain number of lines, or the extent of the spectrum, represented an element, the observation would be open to such errors as might be made were the analysis of a piece of gold or of a diamond to be determined by a measurement of their specific gravity only. But here there is the manifest identity of very bright lines of the artificial spectrum with the very dark ones of the sun, broad lines with broad, narrow with narrow, and double with double. With so vast a number of lines, many of which have a very perceptible width, there must be coincidences now and then; thus in the Fraunhofer line E, which is not a single one, but a group, there are several coincidences of the iron lines with those of calcium. There is a similar coincidence at G, while at $H_1$ and $H_2$, which are lines of great intensity in the calcium spectrum, there are two somewhat faint iron lines occupying exactly the same position.

Not only can each element be distinguished by its characteristic spectrum, but many compound substances, such as blood, chlorophyll (the green colouring matter of leaves) dyes, and wines, may be recognised and analysed by the observation of its spectrum. Such liquids are examined in tubes by transmitted light, and the spectrum readily detects, for instance, any artificial colouring of wine. The differences between the spectrum of arterial blood and that of venous blood have thrown light on several important physiological problems. For example, certain peculiar bands are present when the blood contains a minute quantity of carbonic oxide, and thus poisoning by charcoal fumes can be readily detected. One thousandth part of a grain of blood is sufficient to reveal the characteristic spectrum to a practised eye.

Mr. Sorby, who has given much attention to this subject, has found that the year of vintage of a sample of wine can be determined within one year during the first six years, but that after this the changes are less striking. He took specimens of various ports from the casks, of different ages up to six or seven years, and labelled them in such a manner that he did not know the age of any, but could ascertain it afterwards by reference. He then made the observation with a spectroscope with great care, and found that by proper attention to the bands and their positions he could correctly determine the year of vintage of each particular specimen. It is said that raw fiery whiskey subjected to the passage of a current of electricity is much improved by the electrolytic oxidation of the oils and other offensive constituents; it would be interesting to try whether the same means would age wine in a manner that would deceive both palate and spectroscope.

## THE COLOUR OF WATER.

IT is well known that water is often coloured by the ingredients which it holds in suspension, but when all organic and inorganic matter has been removed, what then is the inherent colour of water? Or is it colourless?

An idea was once prevalent that the water of a sea or lake was blue, by reason of the reflected blue of the sky above, and no doubt the reflected light of the sky has a most important influence on the *apparent* colour of the water. If the sky be deep blue, then this blue light, when reflected by the surface of the water, causes it to appear of a deeper and richer blue. Only fifteen years ago Sir Robert Christison was thought to have proved satisfactorily by experiments that, without the impurities suspended in it, water had no colour. In dry weather the waterfalls presented the purest whiteness, and water from many gravel beds seemed to be brilliantly transparent. It was, then, a natural and excusable delusion on his part to consider that water had no colour. But other scientific men had doubts about this. They were haunted by the idea that water had colour, and they could not account for certain results on the no-colour theory. Sir John Herschel was of opinion that the explanation of many colour phenomena had yet to be found, unless the simple but somewhat doubtful hypothesis were granted, that water had a selective power of absorbing colour. Dr. Tyndall next showed by experiment that water had a decided colour. He passed the light from an electric lamp through distilled water in a tube fifteen feet long, and he cast a magnified image of the end of the tube on a screen. In this way he showed that the colour of the water was blue-green. Since then Mr. John Aitken has entered upon a series of experiments, the results of which we are now able to give.

In the first set of experiments he let down into the water, close to a white object, a long metal tube open at one end and closed at the other by a clear glass plate. The object appeared of a most beautiful deep and delicate blue at the depth of twenty feet. This he could not account for by the selective reflection theory, which holds that the colour of the object is due to the light reflected by infinitesimally small particles of matter suspended in the water, because in that case the object would have been illuminated with the complementary colour yellow. He, therefore, adopted the theory that the colour of the water was due to the selective absorption of the water. In the second set of experiments, a very long blackened tube (which had a clear glass plate attached to the lower end), was filled with the purest natural water, and through this a white disc was examined. The light transmitted was found to be blue, because the water absorbed the rays at the red end of the spectrum. In the third set of experiments, objects of different colour were sunk into the water, and these colours were found to change and appear as if they were looked at through a piece of pale-blue glass. A white object appeared blue; a red object darkened as it descended, and soon lost its colour; very brilliant red appeared dark brick-red at the depth of seven feet; a yellow object changed to green, and a purple object appeared deep blue. All these changes indicated an absorption of the red components of the colours. When again, the coloured objects were sunk in water specially prepared and coloured blue by reflection from small particles, the white changed to yellow, the yellow simply deepened in colour, and the purple grew redder. On these experiments was based the hypothesis that water is a blue transparent medium, acting in the same way as a solution of a blue salt, or as a blue-coloured glass.

The concluding test was with distilled water, the purest water obtainable being boiled, and the steam being collected and condensed by a slow process, the distilled water being then used for the experiments. The test was also varied by distilling three different samples of clear water in three different sets of apparatus; one was made of glass, one of brass, and one had a platinum condenser. Mr. Aitken supposed that if the colour was due to impurities, the impurities in the three samples would be different, and that the colours would be different also. When the darkened tubes used in the second set of experiments were filled with these distilled waters, and a white surface was looked at through them, the effect in all was the same—*the colour was blue*, almost exactly of the same tint as a solution of Prussian blue. Assuming, as we do, that the water in no case was chemically pure or absolutely free from suspended particles, we are of opinion that little or no difference would be produced by distilling the water in apparatus made of different materials. Apart from this consideration, however, the broad fact remains that perfectly clear water when distilled gave a characteristic colour.

Another fact of importance must also be noticed. Though the selective absorption of the water determines its blueness, its brilliancy depends on the solid particles suspended in it. A piece of blue glass, or a blue solution, has little colour when looked at from the side on which the light is falling; and light will permeate clear water till it is all absorbed. The brilliancy of some waters must therefore be due to something in suspension. If samples of the water of the Mediterranean taken at different places be examined by a concentrated beam of light, millions of dust particles of different kinds and sizes are detected floating through the water. The solid particles are white, but are more numerous in some places than in others. Little light is reflected when these particles are few, and the colour is then deep blue. But when the particles are more numerous there is an increased reflection of light, and the colour is blue-green. The colour is deep blue in the former case because the light penetrates to a greater depth and becomes more highly coloured than when the particles are more numerous, and the light is prevented from penetrating far. Along the shores of the Mediterranean the water washes the rocks and rubs off the fine particles which make it so beautifully brilliant. At one place, where the limestone is easily rubbed down, the water is brilliantly blue ; at another, on account of the absence of the limestone, the water is duller.

We may therefore conclude that in all probability (1) The selective absorption of water determines its blue colour, and that (2) The dust particles held in suspension determine its brilliancy. This can be familiarly illustrated. If a dark metal vessel be filled with a weak solution of Prussian blue, the liquid will appear quite dead and void of colour. But if a little fine white powder be thrown into the solution, the liquid becomes of a deep blue colour; and when more powder is added, the liquid becomes of a brilliant blue, the brilliancy increasing with the addition of the white powder.

## PASTEUR'S TREATMENT OF HYDROPHOBIA.

Extracts from the Report of the Committee of Inquiry appointed by the Local Government Board.

IN order to answer the several questions involved in the inquiry, we found it necessary that some of the members of the Committee should, together with Mr. Victor Horsley, the Secretary, visit Paris, so as to obtain information from M. Pasteur himself, and observe his method of treatment, and investigate a considerable number of the cases of persons inoculated by him ; and, further, that a careful series of experiments should be made by Mr. Horsley on the effects of such inoculation on the lower animals. The detailed facts of these observations and experiments are placed in the Appendix to this Report; a summary of them, and the conclusions which we believe may be drawn from them, are given in the next following pages.

The experiments by Mr. Horsley entirely confirm M. Pasteur's discovery of a method by which animals may be protected from the infection of rabies. The general facts proved by them may be thus stated :

If a dog, or rabbit, or other animal be bitten by a rabid dog and die of rabies, a substance can be obtained from its spinal cord which, being inoculated into a healthy dog or other animal, will produce rabies similar to that which would have followed directly from the bite of a rabid animal, or differing only in that the period of incubation between the inoculation and the appearance of the characteristic symptoms of rabies may be altered.

The rabies thus transmitted by inoculation may, by similar inoculations, be transmitted through a succession of rabbits with marked increase of intensity.

But the virus in the spinal cords of rabbits that have thus died of inoculated rabies may be gradually so weakened or attenuated, by drying the cords, in the manner devised by M. Pasteur and related in the Appendix, that, after a certain number of days' drying, it may be injected into healthy rabbits or other animals without any danger of producing rabies.

And by using, on each successive day, the virus from a spinal cord dried during a period shorter than that used on the previous day, an animal may be made almost certainly secure against rabies, whether from the bite of a rabid dog or other animal, or from any method of subcutaneous inoculation.

The protection from rabies thus secured is proved by the fact that, if some animals thus protected and others not thus protected be bitten by the same rabid dog, none of the first set will die of rabies, and, with rare exceptions, all of the second set will so die.

It may, hence, be deemed certain that M. Pasteur has discovered a method of protection from rabies comparable with that which vaccination affords against infection from small-pox. It would be difficult to over-estimate the importance of the discovery, whether for its practical utility or for its application in general pathology. It shows a new method of inoculation, or, as M. Pasteur sometimes calls it, of vaccination, the like of which it may become possible to employ for protection of both men and domestic animals against others of the most intense kinds of virus.

The duration of the immunity from rabies which is conferred by inoculation is not yet determined; but during the two years that have passed since it was first proved there have been no indications of its being limited.

The evidence that an animal may thus, by progressive inoculations, be protected from rabies suggested to M. Pasteur that if any animal or any person, though unprotected, were bitten by a rabid dog, the fatal influence of the virus might be prevented by a timely series of similar progressive inoculations. He has accordingly, in the institution established by him in Paris, thus inoculated a very large number of persons believed to have been bitten by rabid animals; and we have endeavoured to ascertain with what amount of success he has done so.

The question might be answered with numerical accuracy if it were possible to ascertain the relative numbers of cases of hydrophobia occurring among persons of whom, after being similarly bitten by really rabid animals, some were and some were not inoculated. But an accurate numerical estimate of this kind is not possible. For

(1) It is often difficult, and sometimes impossible, to ascertain whether the animals by which people were bitten, and which were believed to be rabid, were really so. They may have escaped, or may have been killed at once, or may have been observed by none but persons quite incompetent to judge of their condition.

(2) The probability of hydrophobia occurring in persons bitten by dogs that were certainly rabid depends very much on the number and character of the bites; whether they are on the face or hands, or other naked parts; or, if they have been inflicted on parts covered with clothes, their effects may depend on the texture of the clothes, and the extent to which they are torn; and, in all cases, the amount of bleeding from the wounds may affect the probability of absorption of virus.

(3) In all cases, the probability of infection from bites may be affected by speedy cauterising or excision of the wounded parts, or by various washings or other methods of treatment.

(4) The bites of different species of animals, and even of different dogs, are, probably, for various reasons, unequally dangerous. Last year, at Deptford, five children were bitten by one dog and all died; in other cases, a dog is said to have bitten twenty persons, of whom only one died. And it is certain that the bites of rabid wolves, and probably that those of rabid cats, are far more dangerous than those of rabid dogs.

The amount of uncertainty due to these and other causes may be expressed by the fact that the percentage of deaths among persons who have been bitten by dogs believed to have been rabid, and who have not been inoculated or otherwise treated, has been, in some groups of cases, estimated at the rate of only 5 per cent., in others at 60 per cent., and in others at various intermediate rates. The mortality from the bites of rabid wolves, also, has been, in different instances, estimated at from 30 to 95 per cent.

The personal investigation of M. Pasteur's cases by members of the Committee was, so far as it went, entirely satisfactory, and convinced them of the perfect accuracy of his records.

The number of deaths assigned by those who have sought to prove the inutility of M. Pasteur's treatment is, as nearly as we can ascertain, 40 out of the 2,682; and in this number are included the seven deaths from bites by wolves, and probably not less than four in which it is doubtful whether the deaths were due to hydrophobia or to some other disease. Making fair allowance for uncertainties and for questions which cannot now be settled, we believe it sure that, excluding the deaths after bites by rabid wolves, the proportion of deaths in the 2,634 persons bitten by other animals was between 1 and 1·2 per cent., a far lower than the lowest estimated among proportion those not submitted to M. Pasteur's treatment, and showing even on this lowest estimate, the saving of not less than 100 lives.

The evidence of the utility of M. Pasteur's method, indicated by these numbers, is confirmed by the results obtained in certain groups of his cases.

Of 233 persons bitten by animals in which rabies was proved, either by inoculation from their spinal cords, or by the occurrence of rabies in other animals or in persons bitten by them, only 4 died. Without inoculation it would have been expected that at least 40 would have died.

Among 186 bitten on the head or face by animals in which rabies was proved by experimental inoculations, or was observed by veterinary surgeons, only 9 died, instead of at least 40.

And of 48 bitten by rabid wolves only 9 died; while, without the preventive treatment, the mortality, according to the most probable estimates yet made, would have been nearly 30.

Between the end of last December and the end of March, M. Pasteur inoculated 509 persons bitten by animals proved to have been rabid, either by inoculation with their spinal cords, or by the deaths of some of those bitten by them, or as certified by veterinary surgeons. Only 2 have died, and one of these was bitten by a wolf a month before inoculation, and died after only three days' treatment. If we omit half of the cases as being too recent, the other 250 have had a mortality of less than 1 per cent. instead of 20 or 30 per cent.

From the evidence of all these facts, we think it certain that the inoculations practised by M. Pasteur on persons bitten by rabid animals have prevented the occurrence of hydrophobia in a large proportion of those who, if they had not been so inoculated, would have died of that disease. And we believe that the value of his discovery will be found much greater than can be estimated by its present utility, for it shows that it may become possible to avert by inoculation, even after infection, other diseases besides hydrophobia. Some have, indeed, thought it possible to avert small-pox by vaccinating those very recently exposed to its infection; but the evidence of this is, at the best, inconclusive; and M. Pasteur's may justly be deemed the first proved method of overtaking and suppressing by inoculation a process of specific infection. His researches have also added very largely to the knowledge of the pathology of hydrophobia, and have supplied what is of the highest practical value, namely, a sure means of determining whether an animal, which has died under suspicion of rabies, was really affected with that disease or not.

The question has been raised whether M. Pasteur's treatment can be submitted to without danger to health or life; and, in answering it, it is necessary to refer to two different methods of inoculation which he has practised, and which are fully described in the appendix.

In the first, which may be called the ordinary method, and which has been employed in the very large majority of cases, the preventive material obtained from the spinal cords of rabbits that have died of rabies derived, originally, from rabid dogs, is injected under the skin, once a day for ten days, in gradually increasing strengths.

In the second or intensive method (*méthode intensive*) which M. Pasteur adopted for the treatment of cases deemed especially urgent, on account either of the number and position of the bites, or of the long time since their infliction, the injections, gradually increasing in strength, were usually made three times on each of the first three days, then once daily for a week, and then in different degrees of frequency for some days more. The highest strength of the injections used in this method was greater than the highest used in the ordinary method, and was such as, if used at first and without the previous injections of less strength, would certainly produce rabies.

By the first or ordinary method, there is no evidence or probability that any one has been in danger of dying, or has in any degree suffered in health even for any short time. But after the intensive method deaths have occurred under conditions which have suggested that they were due to the inoculations rather than to the infection from the rabid animal.

There is ample reason to believe that in many of the most urgent cases the intensive method was more efficacious than the ordinary method would have been. Thus, M. Pasteur mentions that, of 19 Russians bitten by rabid wolves, 3 treated by the ordinary method died, and the remaining 16, treated by the intensive method, survived; and he contrasts the cases of 6 children, severely bitten on the face, who died after the ordinary treatment, with those of 10 similarly bitten children who were treated by the intensive method, and of whom none died; and M. Vulpian reports that, of 186 persons badly bitten by animals that were most probably rabid, 50 treated by the intensive method survived, and of the remaining 136 treated by the ordinary method 9 died.

The consideration of the whole subject has naturally raised the question whether rabies and hydrophobia can be prevented in this country.

If the protection by inoculation should prove permanent, the disease might be suppressed by thus inoculating all dogs; but it is not probable that such inoculation would be voluntarily adopted by all owners of dogs, or could be enforced on them.

Police regulations would suffice if they could be rigidly enforced. But to make them effective it would be necessary (1) that they should order the destruction, under certain conditions, of all dogs having no owners and wandering in either town or country; (2) that the keeping of useless dogs should be discouraged by taxation or other means; (3) that the bringing of dogs from countries in which rabies is prevalent should be forbidden or subject to quarantine; (4) that in districts or countries in which rabies is prevalent, the use of muzzles should be compulsory, and dogs out of doors, if not muzzled or led, should be taken by the police as "suspected." An exception might be made for sheep-dogs and others while actually engaged in the purposes for which they are kept.

There are examples sufficient to prove that, by these or similar regulations, rabies, and consequently hydrophobia, would be in this country "stamped out," or reduced to an amount very far less than has hitherto been known.

If it be not thus reduced it may be deemed certain that a large number of persons will every year require treatment by the method of M. Pasteur. The average annual number of deaths from hydrophobia, during the ten years ending 1885, was, in all England, 43; in London alone, 8·5. If, as in the estimates used for judging the utility of that method of treatment, these numbers are taken as representing only 5 per cent. of the persons bitten, the preventive treatment will be required for 860 persons in all England; for 170 in London alone. For it will not be possible to say which among the whole number bitten are not in danger of hydrophobia, and the methods of prevention by cautery, excision, or other treatment, cannot be depended on.

## EVENING TECHNICAL INSTRUCTION IN ENGLAND.*

FOR the great mass of workmen and other persons engaged in industry, the evening is the only time available for technical instruction. This has been found to be the case in every country in Europe. In France, Belgium, Germany, Austria, and Italy I have visited schools and have been present at courses of instruction in different branches of science and technology, and have noted the increasing importance which is attached to the influence of these courses of instruction upon the condition of workmen and foremen, by manufacturers, and by those who are interested in the question of technical instruction.

In England, evening instruction has been more systematically developed than perhaps in any other country, and for two reasons: the comparatively young age at which the majority of children leave school has rendered evening teaching more necessary than in Germany, for example, where boys remain at school till the age of fourteen; and the shorter hours of labour in England—fifty-six as against seventy-two—have given more opportunity to English artisans to avail themselves of regular and systematic instruction after the day's work is over.

Having regard to the importance of evening teaching, and to the large number of persons in the different towns of France and other countries who profit by it, I have thought that a short notice of the evening courses of science, art, and technology, as organised in England, might be interesting to the members of this section of the Congress.

There are many fundamental differences between the systems of education in England and in other countries, but in none more than in the absence of a central authority in the direction and administration of our schools. This is true as regards all sorts of schools except the public elementary and the evening schools. These are essentially the schools of the people, and are under State control. But middle-class schools, *écoles moyennes*, and schools for higher education are free from Government inspection, and although in some of them, which are partially maintained from the proceeds of ancient endowments, the scheme of instruction is prepared by a commission appointed by the State, the intermediate and secondary schools of England are either the private property of individuals or are governed by councils quite free from State inspection or control. Universities and institutions for higher technical instruction are equally independent. The action of the Government, therefore, in educational matters is restricted to the direction of elementary day schools and of evening instruction in elementary subjects, in science, and in art.

The public elementary schools of England, which are not connected with any religious denomination, are supported partly by rates imposed upon all occupants of houses in the municipality by a council whom they themselves select, and who constitute what is known as the School-board, and partly by the State. But the evening technical schools receive no assistance from the municipality, and the deficit on the subvention granted by the State is provided by voluntary contributions and donations of manufacturers and other friends of education. These schools are under the general direction of local committees, who are responsible for carrying out the regulations in accordance with which alone subventions from the State are made. These subventions are determined, both in the case of elementary as well as of evening schools, by the system peculiar to England, which does not exist, so far as I know, in any other country, and is known as the system of payments on results. Every year at the close of the session in May the students attending evening classes are examined by persons appointed by the State, and subventions are paid to the committees towards the expenses and the maintenance of the schools according to the number of students who satisfy the examiners. I will explain more fully. The teacher (for it is only the teachers at universities and institutions of higher education who are called professors) has a class of thirty pupils, most of whom are artisans who have been studying under his direction the elements of physics. Of these, about twenty pass the examination, eight being placed in the first division and twelve in the second. For each student who passes in the first division the school committee receives £2, and for each pupil who is placed in the second division, £1. The subvention on the result of the examination of the pupils attending this course amounts therefore to £2 × 8 and £1 × 12, or £28, which sum is either given to the instructor, in addition to a small salary which he receives from local subscriptions, or goes to defray the expenses of the school. I should add that in each subject there is an elementary course, an advanced course, and a course of honours; and that for each student who obtains the distinction of honours and is placed in the first division a subvention of £4 is paid, and for those who are placed in the second division, £2. It was necessary to explain in a few words the method of "payment by results," in order that you might understand the system of organisation of evening classes in England.

Evening instruction in science, art, and technology is under the direction of two Departments; the one is a branch of the bureau of education, and is known as the Science and Art Department; the other, which encourages the teaching of the technology of different trades is a comparatively recent association, in no way connected with the Government, and is known as the "City and Guilds of London Institute for the Advancement of Technical Education."

The Science and Art Department encourages in several different ways the teaching of science and of art, both in London and in all parts of the kingdom. The subvention of evening courses is only one part of its operations. Under its direction are two Normal Schools of Science—one at South Kensington and one at Dublin—the School of Mines, and the School of Decorative Art at South Kensington, and the well-known Industrial Museums of South Kensington and Bethnal Green, of which Sir Philip Cunliffe-Owen is director. The secretary of the Department and the director of the science instruction is Colonel Donnelly. The Department was placed under its present direction in the year 1856, having been originally established in 1853, soon after the first International Exhibition, from which year the commencement of technical education, especially of education in art as applied to industries, may be said to date.

The Department receives yearly from Parliament a sum of money to defray the expenses of its work. In 1856-57 the sum voted was £64,675, and in 1885-86 it had increased to £391,573. The money so voted is expended in the payment of teachers on the results of the examination of their pupils in science and in art, in prizes and in bursaries awarded to distinguished students, in assisting in the building of laboratories and the purchase of apparatus, and in the maintenance of the Normal Schools in London and

* Translation of a paper by Sir Philip Magnus, read before the Industrial Section of the Technical Education Congress held at Bordeaux.

Dublin and of the Museums. In 1859, when the system of making subventions for instruction in science and art was first introduced, the subjects of scientific instruction were only six. The subjects of science, towards instruction in which subventions are now given, are twenty-five, viz. :—

Practical Plane and Solid Geometry.
Machine Construction and Drawing.
Building Construction.
Naval Architecture and Drawing.
Pure Mathematics.
Theoretical Mechanics.
Applied Mechanics.
Sound, Light, and Heat.
Magnetism and Electricity.
Inorganic Chemistry.
Organic Chemistry.
Geology.
Mineralogy.
Animal Physiology.
Botany.
Biology (including Animal and Vegetable Morphology and Physiology).
Principles of Mining.
Metallurgy.
Navigation.
Nautical Astronomy.
Steam.
Physiography.
Principles of Agriculture.
Hygiene.

The "Directory" of the Department contains a programme of the course of instruction in each of these subjects, showing the order in which the subjects should be studied, the general character of the experiments to be performed, and the methods of instruction to be adopted by the teachers.

The greater part of the schools for technical instruction which now exist in all the large towns, were formerly known as "Mechanics' Institutes," and were used more for recreation than instruction. In fact, they were clubs for working men, in which occasional popular lectures on literature and science were given. Gradually, however, under the influence of South Kensington, systematic courses of instruction in different branches of science were begun, and as these were found to supply a definite want, the number of such courses increased. As time went on, laboratories were fitted in these institutions for practical instruction in chemistry, and suitable apparatus and models were obtained for the teaching of physics and of mechanics. Every improvement that was introduced into the scheme of examination at South Kensington produced a corresponding improvement in the method of teaching in the provincial centres, and in the character of the work examined. From early times reading-rooms were attached to mechanics' institutes, and gradually books on science and on its applications were added to the works on history, travel, and fiction, which at first were the only books found on the shelves of these libraries. As the number of students increased and their requirements outgrew the capabilities of these institutes, efforts were made to erect and equip schools for the teaching of science. To the establishment of such schools the Department contributed not more than £500, the greater part of the funds being supplied from local sources. In some cases the school was built by the benevolence of one philanthropic person; in other cases the money was laboriously collected by subscriptions; and very often help was afforded by the guilds of the City of London.

The addition of courses on technology to those in science, and the strong demand for technical education, which has everywhere been evinced during the last six years, hastened the conversion of these mechanics' institutes into technical schools. Side by side with these schools of science and technology have arisen schools of art, which possibly have had a still greater effect than the schools of science in improving the manufactures of England. Such schools have been established in all our great centres of industry, sometimes in the same building as the science school and the local museum or library.

Of schools, under the State, in which science or art is taught, there are now 1,984, and the number of students during last session in the schools of science alone was 94,838. In these schools there are now 208 laboratories for instruction in chemistry, with places for 14,587 students. In all these schools the session lasts from October till May. The committee of the school select such of the twenty-five subjects of instruction as have reference to the industries of the town, or for which a demand exists, and they appoint teachers. Each teacher must be registered by the Department. The qualifications for a teacher's certificate are easily obtained: and as a consequence the instruction, in many cases, is not of a very high character. Indeed, it is only in the case of teachers of public elementary schools that anything like a systematic training is required. In all other cases "free trade" may be said to exist in education. Each teacher is obliged to give at least twenty-eight lessons during the session. Inspectors are appointed by the Department, who visit the classes and see that the rooms are furnished with the necessary models and apparatus for teaching. Under certain circumstances the State, through the agency of the Department, contributes one half the cost of apparatus and models, catalogues and specimens of which are kept at the Central Office at South Kensington. These catalogues contain a description and prices of apparatus, diagrams, etc., to illustrate the teaching of (1), geometry, machine, and building construction; (2), physics; (3), chemistry and metallurgy; (4), geology, biology, and agriculture.

At the close of the session an examination is held simultaneously in all parts of the kingdom in each of the twenty-five subjects. The examination occupies little more than twenty-one days, from about the 4th till the 28th of May. The examination papers are prepared in London at the Central Office, and they are forwarded to the different towns so as to arrive on the morning of the examination. At each town a secretary is appointed to receive the examination papers, and the examination is conducted under his superintendence. The candidates being all seated, the superintendent reads out the regulations, and at seven o'clock the questions are distributed. Three hours are allowed for the examination, and at ten o'clock precisely the answers are collected, packed, and forwarded to London. The "Directory" contains most minute regulations for the conduct of these examinations, on the results of which depend the amount of subvention which each school receives from the State. In several subjects, in chemistry, in metallurgy, in botany, in physiology, and in naval architecture, practical examinations are held in the school laboratories. Some idea may be obtained of the expansion of this system from the fact that in the session 1884-85 the number of students who received evening instruction in the Science and Art Department was 78,810, of whom 48,497 were examined. Many of these were examined in more than one subject, and thus the number of sets of answers examined was 114,348. The subvention of the State on the results of this examination was £63,365, being about 16s. 1d. for each student who received instruction. It must, however, be understood that this sum does not represent the entire cost of the instruction, but only the amount contributed to it by the State.

*(To be continued.)*

## THE ROYAL INSTITUTION.

### The Applications of Photography in Astronomy.

ON June 3rd, Mr. David Gill, LL.D., F.R.S., Her Majesty's Astronomer at the Cape of Good Hope, delivered a lecture on the above subject, and said:—

On the 16th of April last there was held at Paris a congress, attended by upwards of fifty astronomers and physicists, representing nearly every civilised nation in the world. It was convened for the purpose of considering a scheme of international co-operation in the work of charting the sky on a large scale. Or, rather, its object was to obtain a series of pictures, which, taken within a comparatively limited period of time, and with the necessary precautions, would enable astronomers of the present day to hand down to future generations a complete record of the positions and magnitudes of all the stars in the heavens to a given order of magnitude. The labours of that conference are now concluded, certain important resolutions have been adopted, and the way has been so far cleared for giving these resolutions practical effect.

The brothers Paul and Prosper Henry have been engaged since 1871 in the construction of charts of the Ecliptic by the older processes of observation, but when they reached that portion of the heavens where the Milky Way crosses the Ecliptic, the number of stars became so overwhelming that the task of charting seemed almost too great for human patience and skill. But, fortunately, the time had come when dry plate photography could be called in to aid, and this aid was in the hands of men singularly competent to develop such an opportunity to the fullest extent. The brothers Henry had long aspired to be not only distinguished practical astronomers, but, following the traditions of Huyghens and the Herschels, they desired also to be the artists of their own optical means. Bound together by strong brotherly affection and common tastes, gifted alike with practical talents of a high order, and with an energy and determination of character that permit no obstacle to success, these men thus happily united have devoted the spare hours of their busy astronomical duties at the Paris Observatory, first to the study of optics, and afterwards to the grinding and polishing of lenses and specula, which have won for them a now world-wide reputation as opticians of the highest rank. I had the pleasure, a few weeks ago, of visiting the modest workshop attached to their house at Montrouge, and I shall not soon forget that visit, nor the many lessons, moral as well as practical, which I learned. Every detail of their process of working has been evolved by themselves; they employ no assistant, and their every appliance is simple and practical in a degree which I can only compare with the simple and practical character of the men who designed it. Such were the men above all others to develop the application of photography to the charting of the heavens. They had high appreciation of the value of the work which they were about to undertake, they had the fullest knowledge of the requirements of the case, and they had the practical skill which enabled them to perfect the necessary apparatus. Their first attempts were made with a telescope of six inches aperture (the object-glass being specially ground for photographic work), and the tube was temporarily adapted to an existing equatorial stand. With an exposure of forty-five minutes, pictures of stars were obtained to the 12th magnitude, in which the star discs were quite round and sharply defined. Fully appreciating the beauty of this result, and seeing its importance, Admiral Mouchez boldly faced many administrative difficulties, and accepted without delay the proposals of the brothers Henry to construct an object-glass of thirteen inches aperture and about eleven feet focal length, as well as the offer of M. Gautier to mount the same on a suitable stand. The new instrument was mounted in May, 1885, and, both from an optical as well as a mechanical point of view, it was admirably adapted for its intended work, and the results obtained by the brothers Henry, and rapidly published and circulated by Admiral Mouchez, at once astonished and delighted the astronomical world.

Before the conference, a great many people—I will not say astronomers—held that the chief object was to photograph as many stars as possible, and simply preserve these plates or issue photographic copies of them, so that astronomers of the future, by merely comparing one of these originals or copies with a similar photograph of the same part of the sky taken 50 or 100 years hence, would find out what stars had changed in position or magnitude, or whether any new star had appeared. There is no doubt this was the view of the popular writers—it is very easily understood, and it appeals very directly to the imagination. Such a project alone would no doubt have had great importance, and would probably in the future have brought to light a great many very interesting isolated facts. But for the broader and more refined purposes of astronomy, for the discussion of such great questions as the motion of the solar system in space, the common movement of large groups of stars, the accurate determination of precession, and the general refinement of astronomy of precision, these mere pictures would have no value. It was essential for these larger and more permanently important ends that all data should be provided for the most refined determination of the *absolute* position of any star upon any plate. This view was endorsed by the congress. The objects of the survey of the heavens to be carried out were defined ultimately thus:—"To make a photographic chart of the sky for the present epoch, and to obtain the data for determining the positions and magnitudes of all the stars to the 14th magnitude," as that magnitude is at present defined in France.

It no doubt produces a strong effect on the imagination to be told that astronomers are to be engaged on making charts of the sky which will contain 60 or 100 millions of stars, or photographing stars on their plates which cannot be seen at all in the most powerful telescopes. There is thus a strong temptation to yield to this demand for sensation, to produce a few astonishing plates with the loss of much precious time, and to sacrifice the real progress of astronomy to the love of the marvellous. Besides, what are you to do with pictures of 100 millions of stars when you have got them? What would be the use of pictures of all these stars, unless at some future time a sufficient number of astronomers were to arise to compare similar photographs, taken, say, one hundred years hence, with the photographs taken in our day? I am happy to think that the number of men who devote themselves to the pursuit of astronomy is on the increase, but I have no desire that the number of men in Great Britain who occupy themselves exclusively with astronomy will ever correspond with that in the floating island of Laputa, as described by Dean Swift, where all the men were exclusively occupied with astronomy, and had to be flapped on the head with little bladders containing parched peas to arouse them from their abstract occupations. And yet, unless something of this sort happens, I see no adequate prospect of the utilisation of pictures of 100 millions of stars.

The congress, therefore, very wisely limited there chart plates to the 14th magnitude. But, as was well said by M. Bouquet de la Grye, it was not necessary to summon fifty or sixty astronomers to a congress to arrange for taking mere photographs of stars—a number of photographers, provided with instruments like the Henrys, could have done all that without a congress. It was very strongly felt that the true *raison d'être* of the Conference was to secure astronomical data, precise and exact as the operations of astronomers should be.

Accordingly they resolved that—

"In addition to the duplicate series of plates giving all the stars to the 14th magnitude, there should be a series of plates of shorter exposure to insure a greater accuracy in the micrometric measurement of the standard stars, and to render the construction of a catalogue possible. The plates intended for the formation of the catalogue shall contain all the stars to the 11th magnitude inclusive." That is to say, it was determined to catalogue the absolute places of stars to the 11th magnitude.

But no photographic plate of itself gives us any information about the absolute places of stars, though it gives the means to determine the relative positions of the stars on the limited area of each plate; you must trust to the old-fashioned meridian observations to determine the absolute places of the brighter stars on each plate, and then measure the position of the fainter stars relative to these standard stars.

I need not enter into detail about the technical means which are to be taken for eliminating the various sources of error, such as contraction of the photographic film in course of development, and so forth. The chart of stars to the 14th magnitude will be of importance for many purposes, such as the search for minor planets, and the trans-Neptunian planet, for variable stars, and for data as to the law of distribution of stars of the higher order of magnitude. But I do not hesitate to say that the work which astronomers of future generations will be most grateful for, and which will most powerfully conduce to the progress of astronomy, will *not* be the chart but the catalogue.

## THE GEOLOGICAL SOCIETY.

A MEETING was held on June 8, Prof. J. W. Judd, F.R.S., President, in the chair, when the following communications were read:—

1. "A Revision of the Echinoidea from the Australian Tertiaries." By Prof. P. Martin Duncan, M.B., F.R.S., F.G.S.

After calling attention to a previous paper by himself published in the Society's Journal for 1877, and to additions to the fauna made by Prof. R. Tate and Prof. M'Coy, the author proceeded to give notes on the characters, relations, and nomenclature of 29 species of Echinoidea. A few notes were added on the relations between this fauna and that now inhabiting the Australian seas, also on the connections with the Tertiary Echinoidea of New Zealand, Sind, etc.

2. "On the Lower Part of the Upper Cretaceous Series in West Suffolk and Norfolk." By A. J. Jukes-Brown, Esq., B.A., F.G.S., and W. Hill, Esq., F.G.S.

The district described in this paper is that of West Suffolk and Norfolk, and is one which has never been thoroughly examined; for no one has yet attempted to trace the beds and zonal divisions which are found at Cambridge through the tract of country which lies between Newmarket and Hunstanton. Until this was done the Hunstanton section could not be correlated definitely with that of the neighbourhood of Cambridge. It was the authors' endeavour to accomplish this, and the following is an outline of the results obtained by them.

The chief interest of the paper probably centres in the Gault, and its relations to the Chalk Marl and the Red Chalk. Quite recently the very existence of Gault in Norfolk has been disputed, but the authors think the facts they adduce and the fossils they have found will decide that point. The Gault at Stoke Ferry is about 60 feet thick, and in the outlier at Muzzle Farm *Ammonites interruptus* occurs plentifully in the form of clay-casts with the inner whorls phosphatized. At Roydon a boring was made, which showed the Gault to be about 20 feet thick, the lower part being a dark blue clay, above which were two bands of limestone enclosing a layer of red marl, and the upper 10 feet were soft grey marl; the limestones contained *Amm. rostratus*, *Amm. lautus*, *Inoceramus sulcatus*, and *Inoc. concentricus* (?), while the marls above contained *Belemnites minimus* in abundance. At Dersingham another boring was made, which proved the grey marl (2 feet) to overlie hard yellow marl, passing down into red marl which rests on Carstone. The grey marl thins out northward, and as the red marl occupies the position of the Red Chalk, the authors believe them to be on the same horizon, an inference confirmed by the presence of Gault *Ammonites* in the Red Chalk.

Another point of importance is the increasingly calcareous nature of the Gault as it is followed northward through Norfolk. This was regarded as evidence of passing away from the land supplying inorganic matter, and approaching what was then a deeper part of the sea; this inference is borne out by the microscopical evidence.

As regards the Chalk Marl, it also becomes more calcareous; at Stoke it is still over 70 feet thick, and its base is a glauconitic marl which can be traced to Shouldham and Marham, but beyond this the base is a hard chalk or limestone, which is conspicuous near Grimston and Roydon, and passes, as the authors believe, into the so-called "sponge-bed" at Hunstanton.

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## SCOTTISH METEOROLOGICAL SOCIETY.

THE report by the Council of this Society states that the secretary's time which is available for investigation has been devoted partially to the preparation of the statistics of the monthly rainfall of the British Islands, but more particularly to an exact comparison of all the observations of storms made at the lighthouses round the Scottish coasts since December, 1883, with the storm warnings issued by the office in London, and the important bearing of the observations made at the Ben Nevis Observatory on the results thus obtained. This is one of the largest and most important inquiries which the Society has yet engaged with, but from the enormous amount of merely mechanical labour which must be gone through in carrying it out, the Council desire to state that some time must yet elapse before the investigation can be completed, unless means be taken to give the secretary assistance in the office during the coming year.

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## ROYAL METEOROLOGICAL SOCIETY.

THE concluding meeting of this Society for the present session was held on June 15th, at the Institution of Civil Engineers, Mr. W. Ellis, F.R.A.S., President, in the chair.

The following papers were read:—

1. "Amount and Distribution of Monsoon Rainfall in Ceylon generally, with remarks upon the rainfall in Dimbula." By Mr. F. J. Waring, M.Inst.C.E. The principal feature in Ceylon, as determining both the amount and distribution of rainfall, is a group of mountains situate in the south-central portion of the island, equidistant from its east, west, and southern shores. The south-west and north-east monsoons in Ceylon may be said respectively to blow steadily from May to August inclusive, and from November to February inclusive. In March and April, and in September and October, the weather is more or less unsettled, and no regular monsoon or direction of the air current is usually experienced. After giving details of the rainfall at twenty-five stations, the author concludes by remarking upon:—1, The effect of the mountain zone in determining the amount and distribution of the rainfall; 2, the apparent gradual veering of the rain-bearing currents of air as each monsoon progresses; 3, the relative insignificance of the south-west monsoon as compared with the north-east monsoon in inducing rainfall; 4, the cause of the large general rainfall of the north-east monsoon throughout the island generally as compared with that of the south-west monsoon; and 5, The influence of the gaps in the external ring of the mountain zone, and of the central as well as the other ridges in it, in determining the amount of rainfall within the zone and in the neighbouring districts outside it.

2. "Note on a Display of Globular Lightning at Ringstead Bay, Dorset, on August 17th, 1876." By Mr. H. S. Eaton, M.A., F.R.Met.Soc. Between 4 and 5 p.m. two ladies, who were out on the cliff, saw, surrounding them on all sides and extending from a few inches above the surface to two or three feet overhead, numerous globes of light, the size of billiard balls, which were moving independently and vertically up and down, sometimes within a few inches of the observers, but always eluding the grasp. Now gliding slowly upwards two or three feet, and as slowly falling again, resembling in their movements soap bubbles floating in the air. The balls were all aglow, but not dazzling, with a soft, superb iridescence, rich and warm of hue, and each of variable tints, their charming colours heightening the extreme beauty of the scene. The subdued magnificence of this fascinating spectacle is described as baffling description. Their numbers were continually fluctuating; at one time thousands of them enveloped the observers, and a few minutes afterwards the numbers would dwindle to perhaps as few as twenty, but soon they would be swarming again as numerous as ever. Not the slightest noise accompanied this display.

3. "Ball-lightning seen during a Thunderstorm on July 11th, 1874." By Dr. J. W. Tripe, F.R.Met.Soc. During this thunderstorm the author saw a ball of fire of a pale yellow colour rise from behind some houses, at first slowly, apparently about as fast as a cricket ball thrown into the air, then rapidly increasing its rate of motion until it reached an elevation of about thirty degrees, when it started off so rapidly as to form a continuous line of light, proceeding first east then west, rising all the time. After describing several zigzags it disappeared in a large black cloud to the west, from which flashes of lightning had come. In about three minutes another ball ascended, and in about five minutes afterwards a third, both behaving as the first and disappearing in the same cloud.

4. "Appearance of Air-bubbles at Remenham, Berkshire, January, 1871." By Rev. A. Bonney. Between 11 and 12 a.m. a group of air-bubbles of the shape and apparent size of the coloured indiarubber balls that are carried about the streets, were seen to rise from the centre of a level space of snow within view of the house. The bubbles rose to a considerable height and then began to move up and down within a limited area, and at equal distances from each other, some ascending, others descending. These lasted about two minutes, at the end of which they were borne away by a current of air towards the east and disappeared. Another group rose from the same spot, to the same height, with precisely the same movements, and disappeared in the same direction, after the same manner.

Mr. H. C. Russell, F.R.S., of Sydney, described a fall of red rain which occurred in New South Wales, and exhibited under the microscope specimens of the deposit collected in the rain gauges.

## RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.

*** *The whole of the papers of the Societies referred to are not included in this list.*

### ROYAL SCOTTISH SOCIETY OF ARTS.

July 11.—Papers read, "Modern Harbour Construction," by Mr. A. Brebner; "On Primrose's Electric Meteorological Scale Reader," by Mr. G. R. Primrose. Reports by Committee, "On Mr. J. Stephen's Tele-Barometer and Automatic Replacement Indicator," Dr. Ferguson, *Convener*; "On Dr. Strethill Wright's Hydraulic Exhaust Pump," Dr. Taylor, *Convener*; "On Mr. Plenderleith's Snow Plough," Mr. Cunningham, *Convener*; "On Dr. Black's Perpendicular Ventilation," Dr. Duncanson, *Convener*; "On Mr. Forgan's Paper on Micro-Photography," Dr. Taylor, *Convener*; "On Mr. Frazer's Papers, Economical Meteorology and a Method of Graduating Barometers," Mr. Heath, *Convener*; "On Mr. Booth's Automatic Emergency Brake," Mr. Miller, *Convener*.

### GEOLOGICAL SOCIETY.

June 23.—Papers read, "On Nepheline Rocks in Brazil, with special Reference to the Association of Phonolite and Foyaite," by Mr. O. A. Derby; "Notes on the Metamorphic Rocks of South Devon," by Miss C. A. Raisin; "On the Ancient Beach and Boulders near Braunton and Croyde in North Devon," by Prof. T. McKenny Hughes; "Notes on the Formation of Coal-seams, as suggested by evidence collected chiefly in the Leicestershire and South Derbyshire Coal-field," by Mr. W. S. Gresley; "Note on Some Dinosaurian Remains in the Collection of Mr. A. Leeds," by Mr. J. W. Hulke; "Notes on Some Polyzoa from the Lias," by Mr. E. A. Walford; "On the Superficial Geology of the Southern Portion of the Wealden Area," by Mr. J. V. Elsden; "Report on Palæo-botanical Investigations of the Tertiary Flora of Australia," by Dr. Constantin Baron von Ettingshausen; "On Some New Features in *Pelanechinus corallinus*," by Mr. Groom; "On Boulders found in Seams of Coal," by Mr. J. Spencer.

### PHYSICAL SOCIETY.

June 25.—Papers read, "Note on Magnetic Resistance," by Professors W. E. Ayrton and J. Perry; "Sounding Coils," by Messrs. W. Stroud and J. Wertheimer; "Comparing Capacities," by Mr. E. C. Rimington; "The Effects of Change of Temperature in Twisting or Untwisting Wires which have Suffered Permanent Torsion," by Prof. H. Tomlinson; "Permanent Magnet Ammeters and Voltmeters, with Invariable Sensibility," by Professors W. E. Ayrton and J. Perry.

### ROYAL ASTRONOMICAL SOCIETY.

June 11.—Papers read, "The Parallax of 61 Cygni as obtained by Means of Photography," by Prof. Pritchard; "The Form of the Solar Corona as Traceable in the Photographs of Recent Total Eclipses," by Mr. W. H. Wesley; "Observations of the Companion of Sirius made at the Dearborn Observatory," by Prof. G. W. Hough; "A Catalogue of 480 Stars to be used as Fundamental Stars for Observations of Zones between 20° and 80° South Declination," by Prof. Auwers; "On the Orbit of $\Sigma$ 1757," by Mr. J. E. Gore; "Physical Observations of Saturn in 1887," by Mr. T. G. Elger; "Measures of Southern Double Stars," by Mr. H. C. Russell; "A New General Catalogue of Nebulæ and Clusters of Stars," by Mr. J. L. E. Dreyer; "An Old Drawing of Jupiter," by Capt. W. Noble; "Remarkable Performance of the Westminster Clock," by Mr. T. Buckney; "On a Corrector for adapting an Ordinary Object-glass to Photography," by Mr. W. H. M. Christie.

### CHEMICAL SOCIETY.

June 16.—Papers read, "The Thermal Constants of a Liquid Mixture," by Professors W. Ramsay and S. Young; "Derivatives of Hydrindonaphtene and Tetrahydronaphthalene," by Mr. Perkin, jun.; "The Formation of Closed Carbon Chains in the Aromatic Series," by Messrs. F. S. Kipping and W. H. Perkin, jun.; "The Action of Ethylene on Ethylic Sodacetoacetate," by Dr. P. C. Fraser and Mr. W. H. Perkin, jun.; "Derivatives of Pentamethylene," by Dr. H. G. Colman and Mr. W. H. Perkin, jun.; "Derivatives of Hexamethylene," by Dr. P. C. Freer and Mr. W. H. Perkin, jun.; "An Attempt to Synthesize a Carbon Ring," by Dr. P. C. Freer and Mr. W. H. Perkin, jun.

### SOCIETY OF CHEMICAL INDUSTRY.
#### MANCHESTER SECTION.

June 7.—Papers read, "On a Double Sulphate of Aluminia and Lead," by Dr. G. H. Bailey; "The Relative Reducibility of Isomeric Nitro-Toluenes," by Mr. T. Miniati and Dr. Cohen; "Determination of the Viscosity of Lubricating Oils," by Dr. T. Traube; "A Delicate Test for Bismuth," by Mr. F. B. Stone; "The Largest Black Ash Furnace in the World," by Mr. Watson Smith.

### ATHENÆUM SOCIETY.

June 29.—Paper read, "On Certain Schools of Painting and Styles of Art," by Mr. A. E. Borgen.

### UNITED SERVICE INSTITUTE.

June 15.—Paper read, "Blockade, under Existing Conditions of Warfare," by Admiral P. H. Colomb.

June 24.—Paper read, "Fire Discipline, and the Supply of Ammunition in the Field, as Provided for by Foreign Powers," by Captain W. H. James.

### CHEMICAL AND PHYSICAL SOCIETY.

June 16.—Paper read, "A few Words on Atomic Motion," by Prof. A. W. Williamson.

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SCIENTIFIC EXHIBITION.—In connection with the sixtieth congress of German naturalists and physicians, which is to be held at Wiesbaden in September, there will be an exhibition of the most recent scientific and surgical instruments and apparatus. Particulars can be obtained from the Ausstellungs Committee der 60ten Versammlung Deutscher Naturforscher und Aerzte, 44, Frankfurterstrasse, Wiesbaden.

AMATEUR PHOTOGRAPHY.—The third annual International Amateur Photographic Exhibition will be opened at 108 and 110, Regent Street, W., on October 25. The entrance fees will be given in full to the Photographers' Benevolent Association, which was instituted to assist members, their wives and children, when in distress through sickness, death, or want of employment, by means of immediate grants of money, to grant annual pensions to aged members, and to aid the unemployed members in obtaining situations. An entrance fee of 2s. 6d. has to be paid by each exhibitor, which sum will be handed over in full to the Photographers' Benevolent Association. The prizes are £50 in cash, 2 gold, 15 silver, and 30 bronze medals. Also the "Camera" magazine gold medal, which will be awarded to the exhibitor of the photograph the Editor may deem the best. And the "Amateur Photographer" silver and bronze medals for the most artistic pictures.

THE COUNCIL OF THE SOCIETY OF ARTS have determined to offer prizes to art workmen in the following classes:—1, painted glass, £25, £15, £10; 2, glass-blowing in the Venetian style, £10, £5, £3; 3, enamelled jewellers' work, £25, £15, £10; 4, inlays in wood, with ivory, metal, or other material, with or without engraving, £25, £15, £10; 5, lacquer, applied to the decoration of furniture or small objects, £25, £15, £10; 6, decorative painting on wood, copper, or other material, applied to furniture and internal decoration, £25, £15, £10; 7, hand-tooled bookbinding, £25, £15, £10; 8, repoussé and chased work in any metal, £25, £15, £10. The competing articles must be sent in on or before Saturday, December 3 next, and will be allowed to be sold. Particulars can be obtained from the Secretary of the Society of Arts, John Street, Adelphi, W.C.

MELBOURNE INTERNATIONAL EXHIBITION.—The Government of the Colony of Victoria have decided to hold an International Exhibition of arts, manufactures, agricultural and industrial processes and products, in the city of Melbourne, in celebration of the centenary of the settlement of Australia. The exhibition will be opened on the 1st of August, 1888, and will be closed on the 31st of January, 1889. An executive commission has been appointed by the Governor under the seal of the colony to conduct the exhibition, and its London Committee, who have control of all questions concerning the exhibitors of the United Kingdom, have offices at 8, Victoria Chambers, Westminster.

PARIS EXHIBITION OF AGRICULTURE AND ENTOMOLOGY.—This biennial will take place from August 27 next to September 29, at the Orangerie, one of the terraces of the Tuileries Gardens. The French Minister of Public Works is the President of the Society which organizes the display.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—The sixteenth meeting of this Association will be held at Toulouse from Thursday, September 22, to Thursday, September 29 next. Notice of intention to be present at the meeting should be given to the Secretary, 4, Rue Antoine-Dubois, Paris.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

8443.—ROBERT MCKENZIE, 47, Lincoln's Inn Fields, London. A communication from Henry Weymersch, France. "Electrolytes for electric batteries." 11th June, 1887.

8484.—JOHN SPEIRS, 52, Chancery Lane, London. "Audible signals." (Complete specifications.) 13th June, 1887.

8485.—AUGUSTE HIPPOLYTE MARINONI and JULES MICHAUD, 52, Chancery Lane, London. "Printing machines." 13th June, 1887.

8532.—JAMES ALFORD HOUSE, 323, High Holborn, London. "Looper mechanism for sewing machines." (Complete specification.) 14th June, 1887.

8545.—HENRY POOLEY and JOHN CHATER, 77, Chancery Lane, London. "Weight-printing steelyards." 14th June, 1887.

8578.—JOHN LANDELLS, 15, Algernon Terrace, Tynemouth. "Rotary engines or pumps." (Complete specification.) 15th June, 1887.

8795.—WILLIAM EDWARD AYRTON, City and Guilds of London Central Institution, Exhibition Road, London, and JOHN PERRY, City and Guilds of London Technical College, Finsbury. "Galvanometers with suspended coils." 18th June, 1887.

8881.—ORLANDO JAY SMITH, 46, Lincoln's Inn Fields, London. "Printing shells." 22nd June, 1887.

8891.—WILLIAM SCOTT PRICE, 29, Island Road, Garston, near Liverpool. "Propulsion of ships by screw propeller." 22nd June, 1887.

8903.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from C. Drevs, Germany. "Machines for crushing colza." 22nd June, 1887.

8922.—WALTER NOEL HARTLEY and WILLIAM EDMUND BRANDFORD BLENKINSOP, 4, South Street, Finsbury, London. "Preparation of cobalt sulphate, and its separation from other sulphates." 22nd June, 1887.

8950.—ROBERT ORD RITCHIE, 23, Andalus Road, Clapham, S.W. "Connections for electrical conductors." (Complete specification.) 23rd June, 1887.

9011.—EDWARD JONES, 6, Bream's Buildings, London. "Dynamo-electric generators and motors." Dated 24th June, 1887.

9013.—CARL COEPER, 45, Southampton Buildings, Chancery Lane, London. "Dynamo-electric machines." (Complete specification.) 24th June, 1887.

9058.—FREDERIC OLDERSHAW JERRAM, 6, Lord Street, Liverpool. "Sewing machines." 25th June, 1887.

9105.—JOSEF STYBLO, 8, Quality Court, London. "Lubricators." 27th June, 1887.

9169.—EDWARD PATTERSON, 46, Lincoln's Inn Fields, London. "Miners' safety lamps." 28th June, 1887.

9197.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Edwin James Blood, United States. "Cannon." 28th June, 1887.

9198.—NATHANIEL WATERMAN PRATT, 323, High Holborn, London. "Pneumatic guns." (Complete specification.) 28th June, 1887.

9209.—LUCIEN GUSTAVE HEUSSCHEN, 24, Southampton Buildings, London. "A new explosive." (Complete specification.) 28th June, 1887.

9206.—JOHN HOWES, 6, Lord Street, Liverpool. "Rotary filtering apparatus." 28th June, 1887.

9210.—HAROLD COLLET, 7, Coleridge Road, Finsbury Park, N. "Electro-magnetic telephones." 28th June, 1887.

9227.—CHARLES WIGG, 4, Clayton Square, Liverpool. "Manufacture of bicarbonate of soda, and in apparatus therefor." 29th June, 1887.

9234.—ALEXANDER CRAIGHEAD THOMSON, 96, Buchanan Street, Glasgow. "Facsimile or transfer printing." 29th June, 1887.

9249.—WALTER PROVIS SIMMONS, 53, Chancery Lane, London. "Producing relief blocks for typographic printing." 29th June, 1887.

9299.—GEORGE TALL and WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. "Colouring matter or mordant for dyeing purposes from cotton seed or cotton seed oil." 30th June, 1887.

9304.—WALTER EDMUND KERSLAKE, 6, Kingsley Road, Liverpool. "Photographic instantaneous shutter." 30th June, 1887.

9316.—ROBERT ABBOT HADFIELD, 33, Southampton Buildings, London. "Manufacture of steel." 30th June, 1887.

9331.—JOHN JAMES HARDY, 16, Finkle Street, Stockton-on-Tees. "Miners' safety lamps." 1st July, 1887.

9339.—ALEXANDER WILKINSON, 52, Duke Road, Chiswick, London. "Insulating telegraphic wires, submarine or land." 1st July, 1887.

9361.—THOMAS MARK DENNE, 166, Fleet Street, London. "Producing defined patterns in celluloid." 1st July, 1887.

9377.—FRANCIS HENRY BOYER, 11, Southampton Buildings, London. "Transmitting submarine signals." 1st July, 1887.

9402.—WILLIAM TYLAR, 31, Yates Street, Aston Road North, Birmingham. "Combined folding, metal washing, draining and drying rack for photographic use." 2nd July, 1887.

9432.—JOHN MCQUEEN and WALTER MOORES, 1, St. James's Square, Manchester. "Nipper mechanism of combing machines." 4th July, 1887.

9449.—EDMUND OCTAVIUS EATON, 28, Martin's Lane, Cannon Street, London. (A communication from James Lancaster, New York.) "Improved air gun." 4th July, 1887.

9455.—JOHN CLIFFORD COOK, 68, Fleet Street, London. "Block printing machines for textile or other fabrics." 4th July, 1887.

9473.—ARTHUR WILLIAM EARNSHAW and ARTHUR ALFRED DORRINGTON, of the firm of Earnshaw and Co., New Bridge Street, Manchester. "Gas-engines." 5th July, 1887.

9474.—JOHN PARKINSON, London. "Improvements in the treatment of ores." 5th July, 1887.

9515.—EUGENE WORMS and JEAN BABE, London. "Apparatus for tanning by aid of electricity." 5th July, 1887.

9551.—HENRY HARRIS LAKE, London. "Tack or nail strip making machines." (George Warren Copeland, U.S.) (Complete specification.) 6th July, 1887.

9638.—WILLIAM BEESLEY and JAMES BEESLEY, London. "Steam boilers." 8th July, 1887.

9692.—JAMES HEBBLEWAITE, Manchester. "Treatment of textile fabrics." 11th July, 1887.

9694.—FREDERICK WILFRED SCOTT STOKES, London. "Manufacture and burning of cement." 11th July, 1887.

9698.—ROBERT STEPHENSON and WILLIAM STAFFORD, Newcastle-on-Tyne. "Crank shafts." 11th July, 1887.

9615.—WILLIAM EDWARD JOHNYS, 20, Charles Street, Bradford. "Temples employed in looms for weaving." 8th July, 1887.

9633.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from Marvin Chester Stone, United States. "Paper tubes for the administration of medicines, beverages and the like, and apparatus for manufacturing the same." 8th July, 1887.

9636.—SAM BLAMIRES, 8, Quality Court, London. "Letting off motion of looms for weaving." 8th July, 1887.

9641.—PETER BERTHELOT, 35, Southampton Buildings, London. "Preventing boats and ships from sinking, and for raising them if sunk." 8th July, 1887.

9654.—JAMES JOHN SHEDLOCK, 9, Gracechurch Street, London. "Galvanic batteries." 8th July, 1887.

9661.—ARTHUR NESS, 16, Finkle Street, Stockton-on-Tees. "Applying lubricating matter to journals and bearings." 9th July, 1887.

9663.—ADOLPHE ARBENZ, 108, Great Charles Street, Birmingham. A communication from Messrs. Hurscheim and Bergmann, trading as Eisenwerke Gaggenau, Germany. "Air guns." 9th July, 1887.

9667.—JOHN DIXON, Great Ayton, R.S.O., Yorkshire. "Automatic apparatus for extracting honey." 9th July, 1887.

9715.—GEORGE ADAMS, 50, Bedford Row, London. "Revolving and tilting mould for casting tubes." (Complete specification). 11th July, 1887.

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THE INSTITUTION OF MECHANICAL ENGINEERS.—In accordance with previous announcements, the summer meeting of this Institution will be held in Edinburgh, commencing on the 2nd of August. The following Papers will probably be read:—On the Structure and Progress of the Forth Bridge; Notes on the Machinery employed at the Forth Bridge Works; On the Paraffin Oil Industry in Scotland; Description of the Electric Light on the Isle of May; Description of the New Tay Viaduct; On Electric-Magnetic Machine-Tools; On the Dredging of the Lower Estuary of the Clyde; On the Position and Prospects of Electricity as applied to Engineering.

# Scientific News

## FOR GENERAL READERS.

Vol. I.] SEPTEMBER, 1887. [No. 7.

CONTENTS.



## CURRENT EVENTS.

The Jubilee of the Electric Telegraph.—We assume that our readers are already aware that the gathering of scientific and representative men, which took place to commemorate the fiftieth anniversary of the successful establishment of the first electric telegraph line, was well worthy of the occasion. Sir Lyon Playfair very truly said that what telegraphy has done for the world is incalculable, not only in adding largely to the resources of government, but in having profoundly changed the whole practice of commerce all over the world. Without it the present enormous railway traffic in all civilised countries could not be carried on, and there would be infinitely greater risk of accidents. Buyers and consumers who are separated by immense distances are now brought into rapid communication, and as both are also made acquainted with the ruling prices in the principal markets of various countries, there is much less opportunity for unhealthy speculation. Many other instances could be given, but speaking generally, the whole system of commerce and of government has been altered by telegraphy.

This rapid and successful development is doubtless due to the fact that science and art worked together for a common end. Abstract science alone could not have brought it to a successful issue, nor could the engineer have succeeded without the guidance of science. Professor Stokes remarked that all honour be to those who are so immersed in abstract science that they disregard and even dislike its application, but that he preferred to see science connected with applications thereof, no matter to what purpose; and that, as is well known, Sir William Thomson had tastes similar to his own in that respect. He added that when we apply abstract science to physical subjects, we are enabled to investigate natural phenomena in a manner which could not otherwise be done. But this is not all. When science comes to be applied to the wants of life, scientific men are placed by the practical man in the condition of making experiments which oftentimes would otherwise be impossible. When science comes to be applied to commercial purposes, it then becomes possible to construct instruments on a scale the cost of which would be utterly prohibitory to the purely scientific man. But when these instruments are constructed, it may be, for commercial purposes, the scientific man on his part is able to make experiments with them which often are of great interest from a purely scientific point of view.

Decimal Coinage.—We sincerely trust that the decimal system will be adopted in this country for weights and measures, but we fear that we are not yet within measurable distance of so desirable a consummation. If, however, a decimal coinage is legalised, it will doubtless lead the way to the larger and more important reform: we are therefore watching with interest what is being done in this direction by Mr. Samuel Montagu, M.P., and those associated with him. In June last he headed a deputation to the Chancellor of the Exchequer, and was able to report that the Chambers of Commerce were unanimously in favour of its adoption. Among other things he stated that at the present time merchants usually calculate in decimals, reducing the pounds, shillings, and pence into decimals, then calculating in decimals, and afterwards reconverting the decimals into pounds, shillings, and pence. This cumbersome method was said to be more expeditious than direct calculations in pounds, shillings, and pence; and we ask, could anything be more absurd? Another speaker (the delegate of the British Chamber of Commerce in Paris) remarked that manufacturers in this country had done a great deal to bring the machinery of their factories to the highest pitch of productiveness, but they had done very little to improve the mental machinery by which they made up their costs and prices, and he was so convinced of the value of a decimal currency, that he had recommended his friends in England to calculate the values of goods in pence, setting down the value, however large, of each line in pence instead of in pounds, shillings, and pence.

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For many years calculations in the engineering, shipbuilding, and other industries have been by decimals, and in many manufacturing districts it has been customary to calculate the rise and fall of wages by decimals. Moreover, at the present time every country in the world, except Great Britain and her dependencies, possesses a currency wholly or partially decimalised, and even some of the British possessions—Canada, Ceylon, the Straits Settlements, and Mauritius—have anticipated the mother country. In fact, it cannot be seriously contended that such a change would not be a benefit to this country, if only the temporary inconvenience during the time of making the change could be got over. The Select Committee of the House of Commons appointed in 1853 reported unanimously and strongly in favour of such a change, and at the interview in June last the Chancellor of the Exchequer admitted that in the abstract most persons think it desirable for this country to have the same system of calculation as other countries. It seems now to resolve itself into a question of getting not only Parliament but "the country" to move in the matter, so that the necessary measures may be taken to legalise the change. In furtherance of this a meeting of Members of Parliament interested in the movement was recently held, and it was then decided to ascertain the feeling of the working classes by bringing the matter before the Trades Union Congress at Swansea. We are happy to add that all the Labour Members in the House wish the decimal system to be adopted.

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Plants and the Electric Light.—It appears that very unfortunate results have followed the introduction of the electric light in the Winter Palace of St. Petersburg, many of the ornamental plants used for the decoration of the banqueting halls having been quite spoilt. It is said that the damage to the celebrated collection of palms is especially serious, and that the complete illumination of the rooms for a single night is enough to cause the leaves to turn yellow and dry up, and ultimately to fall off. According to a Berlin newspaper, this injurious effect is attributed to the sudden change from the sunless days of the northern winter, and from the subdued light of the plant houses, to the blinding light of the electric lamps. This, however, is too general a conclusion to be accepted without reserve, and we think it is not improbable that the difficulty might be overcome by enclosing the lamps in suitable glass, so as to screen the plants from the direct action of the heat rays. If arc lamps are used it should be remembered that the light they emit differs from sunlight, and from the usual artificial sources of light, and that special treatment is necessary.

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In our March number we referred to the very interesting experiments made by the late Sir William Siemens on the influence of electric light on vegetable growth. Among other results, he found that when he placed a sheet of clear glass so as to intercept the rays of the electric light from a portion only of a plant—for instance, a tomato plant—in the course of a single night the line of demarcation was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though at a distance from it of nine to ten feet, was shrivelled, whereas that portion under cover of the clear glass continued to show a healthy appearance. It is known to those who have experimented with arc lights, that the skin is often blistered without the sensation of excessive heat, and it was in fact this very effect which led Sir William Siemens to commence these experiments. He certainly established the fact that vegetable growth can be stimulated by electric light, and in proof of this he produced fruit of excellent flavour and colour during the winter months. It would appear therefore that if the right conditions were understood at St. Petersburg, the plants there might be saved.

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Scientific Ballooning.—We appreciate the courage of MM. Jovis and Mallet in attempting to explore regions not hitherto reached, and if it has pleased them to describe their little exploit as a "victory," few will be disposed to deny them such an innocent pleasure. At the same time when we look to what has actually been accomplished, in order to gain useful information, we confess it is somewhat disappointing. The observations of Mr. Glaisher and others have been numerous, and many of them scientifically accurate; moreover he and Mr. Coxwell did actually reach the great height of 37,000 feet above the sea level. When therefore we find that the "victory" of MM. Jovis and Mallet resolves itself into an ascent of 23,000 feet only, we cannot expect to derive much novel information from their performance. We believe, however, that they were supplied with several recording instruments, and the records of these will doubtless be interesting, and may possibly add to the knowledge already in the world's possession. We trust these records will be published soon.

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The New Soda Process.—Great interest is attached to the experiments with regard to the manufacture of soda, which will shortly take place at Widnes. Upon their success may be said to turn the fate of the makers of soda by the old Leblanc process, a process which during the last few years has been almost supplanted by the ammonia process of Solvay. The experiments are for the purpose of testing the value of an invention of Messrs. Parnell and Simpson, which aims at combining the advantages of both processes. By using the "tank waste" of the Leblanc works, the residual ammonium chloride obtained by the ammonia method is decomposed. The reactions are simple; the ammonium of the ammonium chloride combines with the sulphur existing in the waste as calcium sulphide, to form ammonium sulphide, while a liquor containing calcium chloride remains behind. The ammonium sulphide being in the gaseous form is readily passed into the salt solution, where, on the addition of carbon dioxide, it is decomposed into sulphuretted hydrogen and ammonium bicarbonate, whence, by a double decomposition, is derived the bicarbonate of soda. The sulphuretted hydrogen is, of course, driven off; it is then stored in a gas-holder and, by a process called by the inventors "restricted combustion," is made to yield up its sulphur. If the statements of the inventors that a ton of lime is saved, and six hundredweight of sulphur recovered, for every ton of carbonate produced, are borne out when the process is tried on a large scale, the alkali industry will assuredly enter upon a new phase of its chequered existence.

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University Degrees for Women.—In the face of the record of steady work, crowned by many notable successes, to which the Tripos Examinations of Cambridge bear witness, it seems a strange anomaly that women should still be prevented from taking *de jure* that position which *de facto* they have won for themselves. The anomaly has this year become almost ludicrous, for we are presented with the spectacle of a degree-less Senior Classic, while every "poll" man duly graduates. Cambridge has done much for women, but she must now do more, for such absence of logical consistency is unworthy of the great University. Two steps are necessary. Women must be admitted formally to degrees, and the ordinary or "poll" degree must be thrown open to them. There is a peculiar absurdity in allowing them admission only through the Tripos Examinations, the gate of greatest difficulty; let them enter by any way free to men. The action of the London University in consenting to ignore entirely differences of sex, as of race or colour, is worthy of imitation, though from the absence of many complicating circumstances it does not furnish an exact parallel. Its recent pass and honour lists show that the equality recognised by the University is not one existing in name only: ladies have distinguished themselves in arts, in science, and in medicine; and it certainly is not too much to say that, as far as such tests go, they have conclusively proved the uselessness of such antiquated restrictions as are still held by the older University to be necessary.

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The Technical Education Bill.—In our July number we described the provisions of this Bill, which at one time seemed to have a fair chance of being passed, as it had not been made a party question. The Government have however decided not to proceed with it during the present Session. Sir W. Hart Dyke introduced the Bill in the House of Commons with a judicious speech, but its weak point, no doubt, was the fact that it was merely permissive, and that the administration of the funds would have been practically in the hands of the Science and Art Department, whose management is by many considered extravagant. The funds would have to be provided by the ratepayers, and they might object to have them dispensed by persons more or less irresponsible.

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The British Association.—The meeting at Manchester bids fair to be one of unprecedented importance, and there will not only be a large number of members present, but many foreign visitors of eminence are also expected. The number of papers proposed to be read is said to be very large, and we trust that the recommendations referred to in our last number, for the business conduct of the meeting, may not be unheeded. The local secretaries have published a letter, in which they point out that the main purpose of the Association is to bring together, from various and even remote districts, those who are engaged either professionally or as amateurs in scientific research, or who take an interest in scientific work. Obscure observers and unknown lovers of scientific culture are thus brought into more or less personal relation with the leaders of scientific thought. The numbers present will doubtless be large, and the majority will be eager to profit by the opportunity of instruction thus afforded them.

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The Progress of Medicine.—At the recent meeting of the British Medical Association held in Dublin, Professor Gairdner, the President elect, read an important paper on "Medicine." In the course of his elaborate and interesting address be referred to the evolution of the healing art which, amidst the rise and fall of doctrines, of methods, of tendencies, and currents of opinion, was recognisable as the years went by, and he asked whether there were any ruling principles at all throughout this vast field of medical experience, or was it a mere aggregate of laborious investigations guided by no common purpose, no fixed or polar star? He reminded his audience that a few years ago Sir William Hamilton had even still more pointedly asked the rather startling question: "Has the *practice* of medicine (*i.e.*, the art as distinguished from the science) made a single step since Hippocrates?" Professor Gairdner's conclusion is that no exclusive or single principle or law of the healing art can be said to exist; in other words, he said, the healing of disease is still largely empirical, and what is more, it takes no shame to itself in being and remaining so. It is guided and moulded, every day more and more, by advancing science, but it remains in the end only the application of a more carefully instructed experience. It is true we are told that rational and empirical medicine are not opposed, but that they rather interpenetrate each other more and more, and that each is the better for it. No one knows better than Professor Gairdner what are the actual facts of the case, and doubtless his version is the true one, but we fear that our lay readers will be rather surprised and disappointed.

## GENERAL NOTES.

A Pocket Voltmeter.—This useful instrument has recently been brought out by Messrs. Paterson and Cooper. It is about the size of a large silver watch, and is said to be reliable.

Melinite.—We learn from Berlin that experiments made there, by order of the War Minister, have shown that in course of time this explosive compound decomposes, and that it is therefore unfit for military purposes.

Patents in Switzerland.—The Swiss National Assembly has authorised the State to pass a law for the protection of patented inventions, and as the voting was three to one, there is every probability that effect will be given to this resolution.

Petroleum Wells in Egypt.—It is reported that the latest accounts from the petroleum wells at Jebel Gemseh are satisfactory. The greatest depth reached was 1,200 ft., and the last boring (220 ft. deep) passed through gypsum, which was throughout strongly impregnated with oil.

An Electric Kettle.—According to the *Centrablatt Elektrotechnic*, the Edison Company in Germany has introduced a kettle in which the water is heated by an electric current passing through a resistance coil, placed in a suitable cavity in the kettle. With this apparatus it is said that a litre of water can be boiled in fifteen minutes, at a cost of about one halfpenny.

Telephone-Telegraph.—Colonel Rénard and M. Northombe have invented a system of telephone-telegraphy, which has recently been tried at the French School of War. It is said to answer well, and that an untrained person can easily make use of it. The apparatus is compact, and can be connected with any existing telegraph line, good insulation not being of much importance.

Electric Lighting in the Palais Royal.—It is said that the Edison Company have obtained the permission of the French Government to have the free use of the extensive vaults of the Palais Royal for storage batteries. The Company is to light up the whole of the Palais Royal, the Conseil d'Etat, the Cour des Comptes, and the Théâtre Français, as well as the Menus Plaisirs Theatre.

Biological Station on Puffin Island.—Owing to the exertions of the Biological Association of Liverpool, sufficient funds have been obtained to build a station on Puffin Island, and to purchase a yacht for dredging and other purposes. Professor Herdmann has been working for some time in Liverpool Bay, and has published from time to time some interesting and instructive accounts of his researches.

International Astronomical Congress.—It has been decided that there are to be two series of stellar photographs, the first to include stars to about the eleventh magnitude, and the second to include stars to the fourteenth magnitude, or about fifteen millions altogether. A permanent bureau has also been appointed to carry out the decisions of the Congress, and to keep up communication with the observatories which are to take part in this great astronomical undertaking.

A Telegraph Pole on Fire.—A singular fire occurred in New York a short time ago. One of the immense telegraph poles, so common in the United States, was set on fire by the sparking of two wires, which accidentally came in contact. The pole was in John Street, opposite the building of the Western Union, and there were no less than 150 wires suspended from it. The flames were near the upper end of the pole, and it was with some difficulty that water could be thrown to such a height to extinguish them.

Paper Doors.—We have recently been told of paper barrels and bottles, and now we learn that paper doors are coming into use in America, and it is said that they compare favourably with those of wood, as they neither shrink, swell, crack, nor warp. The doors are formed of two thick paper boards, stamped and moulded into panels, and joined together with glue and potash, and finally rolled through heavy rollers. After being covered with a waterproof coating, and with another which is fireproof, the doors are painted, varnished, and hung in the usual way.

Cutting Glass.—Many of our readers are doubtless aware that glass may be cut under water with great ease, to almost any shape, with a pair of shears or strong scissors. In speaking of this, the *Pottery Gazette* points out that two things are necessary for success. First, the glass must be kept quite level in the water while the scissors are applied; and secondly, to avoid risk, it is better to perform the cutting by taking off small pieces at the corners and along the edges, so as to reduce the shape gradually to that required. The softer glasses cut the best; the scissors need not be very sharp.

Telegraphing in the Sea.—It appears that Mr. Edison's new system of telegraphing at sea without wires depends on the ease with which sound can be transmitted in water. The apparatus he uses is a steam whistle, placed in the cabin of a ship, and the sound it produces is transmitted by a conducting wire to a speaking-trumpet fixed on the hull of the vessel, below the water-line. The sound emitted passes through the water very rapidly, and strikes against another trumpet on the vessel to be communicated with, and this causes an electric bell to ring. Signals can thus be sent to or from either of the vessels.

American Birds.—The special groups, illustrating the nesting habits of British birds, which have proved so attractive in the Natural History Museum at South Kensington, have now been introduced into the galleries of the American Museum of Natural History, and twelve cases of American birds have already been mounted. According to *Nature*, the cost of these effective, but expensive groups will be defrayed by Mrs. Robert E. Stuart, and the Museum has secured the services of Mrs. Mogridge, who executed the artificial flower-work for the British Museum. Mrs. Mogridge is without a rival in this branch of decorative art.

Second hand Corks.—A correspondent of the *Analyst* points out that corks which have been drawn from bottles are allowed to remain in bar-rooms and other places, where they become coated with fermenting vegetation. They are afterwards sold to dealers, who subject them to a kind of bleaching process, and then pass them through a smoothing machine. After this they are sold to bottlers of beer, etc., who use them again. Attention, however, is called to the fact that although a cork may be ever so well cleaned, its internal fissures always retain some of the decomposing vegetable matter, the injurious properties of which are communicated to the liquids they are intended to preserve. This should certainly be prohibited.

The Respiration of Dogs.—At a recent meeting of the Académie des Sciences, M. Charles Richet communicated the result of some experiments he had made on the effect of heat on the respiration of dogs. In the normal physiological state a dog breathes from twenty to thirty times a minute; but when placed in a heated chamber, or when he has been running in the sun, the number of respirations may reach 300 to 350. A dog does not perspire, and the temperature of the animal is kept down solely by a large increase in the evaporation which takes place in the lungs. According to these experiments, a dog which was placed on scales in a heated chamber lost in one hour eleven grammes of water per kilogramme, or 1·1 per cent. of its own weight.

A Novel Clock.—A clock has recently been patented in France in imitation of a tambourine. A circle of flowers, corresponding with the hour figures of ordinary dials, is painted on the parchment, and there are two bees, one large and the other small, which crawl about among the flowers. These bees take the place of the ordinary clock hands, one of them running quickly from flower to flower and completing the circle in an hour, while the other bee moves more slowly and takes twelve hours to complete the circle. The bees are in no way fastened to the parchment, the surface of which is unbroken, but inside the tambourine there are two magnets connected with suitable clockwork, and the bees being made of iron they naturally follow the magnets.

Compressed Air for Electric Lighting.—According to *Industries*, a Company has been formed in Paris for the supply of compressed air to users of dynamo machines for electric lighting. A central station has been provided where engines of 3,000 aggregate horse-power will compress the air for this purpose. The mains are already being laid, and the work is being pushed on with all possible speed to furnish motive power to the theatres within the time allowed by the Government order for the substitution of electric light for gas. With electric lamps and compressed air engines, it is believed the maximum of safety from fire will be attained, and it is added that the scheme is to be extended to the provinces, and that Lille will probably be the first town to adopt it.

Conversion of Heat into Electricity.—We learn from Italy that Messrs. Hurghausen and Nerust have devised a most curious experiment from the scientific point of view. After placing a thin metallic leaf in a magnetic field, they found that if its extremities were maintained at uneven temperatures, there was a difference of potential at the two ends—extremely slight, it is true, but quite appreciable. Moreover, the direction of the current varied with the lines of force of the magnetic field. They used a piece of bismuth five centimetres square and two millimetres thick, and the difference of temperature was obtained by placing two pieces of mica in contact with the ends of the bismuth, one of the pieces of mica being immersed in cold water, and the other heated by a spirit lamp.

The Telephone assists the Telegraph.—It was at one time urged that an extended use of the telephone might be prejudicial to the telegraph, but the reverse is actually the case, and the number of messages sent to telegraphic offices by means of the telephone is very considerable. In Belgium special facilities are given for this purpose to telephone subscribers, and according to statistics just published it appears that during the first five months of the present year 167,838 telegrams were transmitted in this way on the Brussels, Antwerp, Liège, Charleroi, Ghent, Verviers, and Louvaise lines. This is an increase of no less than 37 per cent. over the number sent in the corresponding period of 1886, and throughout Belgium it is estimated that there is an average of 1,200 telegrams per day which are transmitted by telephone.

The Panama Canal.—The *Scientific American* says that in all probability this work will shortly be stopped, and that the projectors are considering the really formidable problems on the solution of which the completion of the work depends. It is alleged that it is not only essential to control the torrents which at certain periods pour down the mountain sides, and which, if unchecked, will render the maintenance of the canal impossible, but that provision must also be made against a mountain which is actually moving slowly into the very path of the canal! Our contemporary adds that the deadliness of the climate and the important difference between the mean level of the two oceans have also to be considered, so that it is not surprising if the engineers in charge are unable to discover practical means of accomplishing their purpose.

Detection of Hot Bearings.—According to *Industries*, M. Gerboz has devised an apparatus by which an audible and visible signal is given to the engine-driver if any part of the machinery to which the apparatus is fitted becomes unduly hot. In its simplest form, as applied to the crank pin of a steam engine, the device consists of a small cylinder fastened to and projecting from the crank pin, and containing a plug of easily fusible alloy, which is pressed against the end of the crank pin by a perforated piston and spring. The piston rod controls a catch belonging to the mechanism of a bell placed over the apparatus, and the gear of the bell, which is actuated by spring power, is previously wound up by hand and locked by the catch. If the crank pin should heat, the fusible plug melts, thus allowing the piston to descend, thereby releasing the catch and sounding the bell.

A Stone in a Hailstone.—The presence of solid substances has often been noticed in melted snow and hail, but never before has a stone weighing two grammes been found in a hailstone. We learn, however, from *La Nature* that such an occurrence has actually been proved by M. Tissandier, and that not only was the stone enclosed as thick as an ordinary sized thumb, but it had evidently been worn down to its present shape. The substance was not analysed, because the stone would have been spoilt, but it appeared to consist of gypsum (sulphate of calcium); it is easily scratched, it is not affected by acids, and its specific gravity is 2·3. This singular stone fell at Tarbes during a violent storm, and it is supposed that it had been carried up into the clouds by a whirlwind, and that there it became a centre of attraction for particles of ice.

Metallic Cement for Stone.—The following metallic cement for repairing broken stone was, according to Professor Brune, of the School of Fine Arts, used in the restoration of the colonnade of the Louvre, of the Pont Neuf, and of the Conservatoire des Arts et Metiers. It consists of a powder and a liquid. The powder—Two parts by weight of oxide of zinc, two of crushed grit, the whole intimately mixed and ground. Ochre in suitable proportions is added as a colouring matter. The liquid—A saturated solution of zinc in commercial hydrochloric acid, to which is added a part, by weight, of ammonium chloride equal to one-sixth that of the dissolved zinc. This liquid is diluted with two-thirds of its bulk of water. To use the cement, one pound of the powder is mixed with two and a half pints of the liquid. It is said that the cement hardens very quickly, and is very strong.

Heating Railway Carriages by Hot Water.—Mr. W. Foulis, of Glasgow, who has invented several useful apparatus heated by gas, has lately introduced a system for heating railway carriages by the waste heat from the gas lamps used to light the roofs of the carriages. This is effected by means of water, a boiler being placed over the gas lamps, having two pipes descending from it, and connected with two tubes under the carriage seats. The hot water circulates through these pipes and returns again to the boiler after having heated the carriage. It is said that the ordinary size of gas flame is sufficient to heat a compartment. To prevent the water being frozen when the carriage is not in use, a little glycerine is mixed with it. We learn that the system has been tried during the past winter on the trains of the Glasgow and South Western Railway in Scotland, with very satisfactory results.

Solubility of Carbonate of Lime.—In his lecture at the Society of Arts, Mr. Dent points out that the solubility of carbonate of lime in water charged with carbonic acid not only gives rise to very remarkable and curious incrustations, but exerts a very considerable influence upon geological limestone formations, the insoluble carbonate of lime being deposited as a sedimentary rock. The white concretionary limestone known as travertin, of which both ancient and modern Rome are largely built, is an example of such a deposit, which is taking place in some parts of Tuscany at the rate of 6 inches a year. Carbonate of lime being deposited from its solution in carbonic acid, serves to bind together other materials with which it comes in contact in the course of the deposition. It thus serves as the binding material of several varieties of building stone, and becomes an important agent in the formation of rocks.

The Builders of the Pyramids.—A personal inspection of the pyramids of Egypt made by a quarry owner, who spent some time recently on the Nile, has led him to the conclusion that the old Egyptians were better builders than those of the present day. He states that there are blocks of stone in the pyramids which weigh three or four times as much as the obelisk on the Embankment. He saw a stone whose estimated weight was 880 tons. But then the builders of the pyramids counted human labour lightly, and they had great numbers of subjects upon whom to draw, and most of the work was done by sheer manual labour and force. There are stones in the pyramids thirty feet in length which fit so closely together that a penknife may be run over the surface without discovering the break between them. There is no machinery so perfect as to make two surfaces thirty feet in length meet together in unison as these stones in the pyramids do. It is supposed that they were rubbed backwards and forwards upon each other until the surfaces were assimilated to each other.—*Iron.*

Multiple Writing by Electricity.—Some few years ago, at a time when there was a rage for all kinds of apparatus for multiplying fac-simile copies of handwriting, it will be remembered that Edison brought out an ingenious "electric pen," in which a small needle darting to and fro at great speed made minute perforations in the paper, the printing being effected by an inked roller, which was run over the perforated paper like a stencil plate. The movement of the needle was produced by means of a tiny magneto-motor mounted upon the style, and driven by a couple of bichromate cells. The cells had, however, to be of large size, the motor requiring a good deal of current. Moreover, it was impossible to write very fast with the pen in the first instance, owing to its weight and the necessity for holding it in a vertical position. Recently, M. Garel has succeeded in obtaining similar results by more simple means. He writes with an ordinary black-lead pencil upon very thin paper, which is laid upon a smooth carbon block. The lead of the pencil is connected to one terminal of a small induction coil, and the carbon block to the other terminal. A spark then follows the pencil point, and the paper can be used as a stencil.—*English Mechanic.*

Photo-Sculpture.—We learn from the *Photographic News* that there is now a tendency to revive the so-called photo-sculpture. The photographic guides introduced for this process were ordinarily twenty-four in number, and all the exposures were made simultaneously upon a sitter who was seated with a circular battery of twenty-four cameras directed upon him. Each of the resulting photographs corresponded in its outline to the vertical section of the required bust in one position, and by trimming the photographs so as to obtain cardboard silhouettes, and using each in succession as a guide in cutting out the clay, a rough model of the sitter could be obtained. Photo-sculpture, however, was not a success, and the difficulty of serving twenty-four cameras with wet plates was very great. Now the case is different, as with twenty-four cameras charged with reliable dry plates, and all cameras brought into simultaneous action by an electric or pneumatic uncovering of the lens, one may be reasonably sure of securing all the outlines with certainty. Renewed attention will probably be given to photo-sculpture, and it has recently been the subject of discussion at the meetings of the Photographic Society of France.

The Telautograph.—As its name implies, this instrument reproduces an autographic message. It is the invention of Mr. Elisha Gray, a well-known electrician, and it is said that so far the experiments made with it have been very satisfactory. The electric current is an important factor in the invention, but the chief feature is the plate or instrument on which the writing is done. No particular kind of pen or pencil is required, in fact, a sharp-pointed instrument of any kind will answer the purpose. The paper on which the writing is done, and on which the autograph is reproduced does not have to be prepared; it is the pressure on the plate which gives the impulse to the machine, while the reproduction is brought about by a tracing point, which may be a properly-linked pen, or even an ordinary lead pencil, attached to a movable arm in the receiving machine at the other end of the line. We learn that a number of experiments with the machine have been made at Highland Park, where Mr. Gray's laboratory is, and that all of them have been of the most satisfactory character. The circuit was not a very long one, but the tests showed that the length of the circuit did not matter much, and that the work could be done over many miles of wire.

Cork and its Uses.—Under this heading *Industries* contains an interesting article, and from this we extract the following:—Cork, on examination, is found to consist of lifeless and empty cells, their walls being composed of a substance differing from ordinary cellulose in many ways. Thus it is practically impermeable to fluids, even under a pressure of several atmospheres, yet quite pervious to gases, as the simple experiment of submerging a cork under water and exhausting the air readily shows. The cork, then, is built of a multitude of minute water-tight air chambers, and so long as the contained air does not escape we have a substance which reacts against pressure with the almost perfect permanent elasticity of a confined gas, rather than with the inferior elasticity of ordinary solids. The cork of an old wine bottle shows admirably how long its elasticity is retained, and experiments show that cork may be compressed and released in water many thousand times without diminution of this valuable property. Hence arise some ingenious recent applications; thus gun-carriages are now being made with cork instead of hydraulic "compressors," for storing a portion of the energy of recoil of the cannon in order to run it out again afterwards. In the same way a considerable improvement in the working and efficiency of hydraulic rams is obtained by using cork instead of air as a spring, so as to insure regularity.

THE DESTRUCTION OF STONE.—In a recent number of *La Nature* there was an article on the well-known causes of the destruction of stone used for buildings. A correspondent now points out that, in his opinion, there is another cause which has not yet been spoken of, and that it acts upon the hardest and most resisting materials, such, for instance, as granite. He refers to the sudden expansion produced by the sun while the temperature of the air is low and the weather calm. Among the examples he cites is the following:—At St. Pal-de-Mons (*Haute Loire*), in a public place opposite the church, there is a cross which was erected in 1670, as shown by an inscription on the stone. The vertical limb of the cross is circular, and now presents this peculiarity: a circular layer of the stone, about one centimetre thick, has become detached from the inner portion of the stone, and part of this outer skin or layer rests against the inner trunk, but the other portion stands out independently, and resembles the bark of a fossil tree. The portion which rests against the trunk is on the south side, and it is suggested that the phenomenon has been caused, not by frost, but by a countless number of successive expansions and contractions produced by the sun. The climate where this has occurred is cold and free from fog. The occurrence is no doubt curious and interesting, but we fail to see that there is any proof that it has been caused by the direct action of the sun.

SANITARY ACTION OF RAIN.—We commonly abuse our climate on accounts of its humidity. This is a great mistake. Frequent and moderate rain, such as constitutes the characteristic of the British climate, is the most effective of all sanitary agencies. It cleanses the ground, and, what is far more important, it cleanses the air. The ammoniacal and other exhalations, continually arising from decomposing animal and vegetable matter, are all more or less soluble in water and are largely removed by gentle rain. Besides these it absorbs and carries down into rivers and thence to the sea, the excess of carbonic acid exhaled from our lungs, and produced by our fires and lights. De Saussure found that a shower of rain removed about 25 per cent. of the carbonic acid from the air over the Lake of Geneva. Also that there was less over the lake than over the neighbouring meadows and the great elevations of the Alps where there was no water. The atmosphere over the sea contains less than one-fourth of the quantity in that over the land. Far away at sea the quantity is inappreciable, and at a given place on the coast it varies with the wind, increasing as it blows from the land, and *vice versâ*. All these facts show that water in contact with the air absorbs its carbonic acid in a decidedly practical degree. In densely-populated districts this is of considerable importance. The difference is perceptible to the senses after a long drought, as the common expression, "refreshing showers" indicates. —*Science Gossip*.

HEIGHT OF CLOUDS.—Herren Ekholm and Hagström have published an interesting summary of the results of observations made at Upsala during the summers of 1884-85. They determined the parallax of the clouds by angular measurements made from two stations at the extremities of a base of convenient length, and having telephonic connection. They found that clouds are formed at all levels, but that they occur most frequently at certain elevations or stages. The following are, approximately, the mean heights, in feet, of the principal forms:—Stratus, 2,000; nimbus, 5,000; cumulus (base), 4,500, (summit) 6,000; cumulo-stratus (base), 4,600; "false cirrus" (a form which often accompanies the cumulo-stratus), 12,800; cirro-cumulus, 21,000; cirrus, 29,000 (the highest being 41,000). The maximum of cloud-frequency was found to be at levels of 2,300 and 5,500 feet. Speaking generally all the forms of cloud have a tendency to rise during the course of the day; the change, excepting for the cumulus-form, amounting to nearly 6,500 feet. In the morning, when the cirrus clouds are at their lowest level, the frequency of their lowest forms—the cirro-cumulus—is greatest; and in the evening, when the height of the cirrus is greatest, the frequency of its highest forms—the cirro-stratus—is also greatest. With regard to the connection between the character of the weather and the height of the clouds, the heights of the bases of the cumulus are nearly constant in all conditions. The summits, however, are lowest in the vicinity of a barometric maximum; they increase in the region of a depression, and attain their greatest height in thunderstorms, the thickness of the cumulo-stratus stretching sometimes for several miles. The highest forms of clouds appear to float at their lowest levels in the region of a depression.

CONCRETE SPOILT BY SEA-WATER.—A matter of the highest possible importance and interest to all connected with the construction and management of harbours has been brought to light at Aberdeen. The Aberdeen Harbour Commissioners opened a graving dock two years ago, formed of Portland cement concrete, the steps being lined with granite ashlar. A few months since it was noticed that the concrete entrance walls, which are not lined with granite, had become swollen, and that the surface had begun to show cracks. Investigation as to the cause was at once made, and Mr. W. Smith, the harbour engineer, suspecting that chemical action was inducing the mischief, conferred with Professor Brazier, of Aberdeen University, who analysed briquettes of the Portland cement used in the construction of the graving dock, and also samples of the concrete taken from the entrance walls of the dock. From the analysis made it appeared that the action of the sea-water on the Portland cement itself, as well as on the cement in the concrete, caused an expansion and softening of the cement in consequence of the deposit of magnesia from the sea-water, and also led to the formation of carbonate of lime by the union of the carbonic acid contained in the sea-water with the lime in the cement. This somewhat startling discovery must necessarily receive great attention. Within the past quarter of a century a great number of sea-works have been formed of Portland cement concrete. In the case of the graving dock at Aberdeen it has required patching since its construction fifteen years ago, but the idea that its defects were due to chemical action did not occur to the harbour engineer till last year. The remarkable point in regard to this graving dock is the rapidity of the chemical action of the sea-water upon it, as compared with the length of time that similar action has had opportunity of taking effect on sea-works. We understand the greater effect is ascribed to the fact that the pressure of the water in the dock is much heavier than is the pressure of water on the sea-works. In the former case the pressure is from five to eleven pounds per square inch; in the latter it must be very light except when the waves drive heavily against the works. Till the present time there does not appear to have been any investigation as to the chemical action of sea-water upon concrete. Now that science has been called in, and has made the discovery that concrete must give way before the sea, it will be the task of chemists to look out for some countervailing substance which shall prevent the decay which seems to be inevitable. It is something that science has shown the danger that is being run; it will redound more to the honour of scientific men if they can indicate the means by which the impending calamity can be avoided. The subject came before the Harbour Board of Aberdeen recently, and they resolved to hold a meeting of the whole Board in committee to consider the matter.—*Dundee Advertiser*.

## DOMESTIC SANITATION.

### No. 5.—Sewage Treatment.

THE aim in sewage precipitation is to add to the foul liquid some substance by which its impurities are deodorised, rendered insoluble, and caused to subside to the bottom of the tank, leaving above a layer of clear water, which may safely be let flow into any river.

All this sounds exceedingly simple, but in practice it is beset with not a few difficulties. This we shall at once admit if we consider the multitude of processes which have been projected and patented, many of them utterly absurd, and many more, to say the least, quite impracticable. It must be kept in view that the impurities in sewage and in the waste waters of manufacturing establishments resolve themselves into two main classes—suspended matters, and such as are present in the form of solution. To the former class belong all solid bodies, filaments derived from washing garments, the excrements of animals, and fragments of meat. The presence of the latter is shown by the eagerness with which crows, sea-gulls, etc., hover over sewage-tanks and open sewers, watching to snatch up any floating morsel.

The dissolved, or, at least, soluble impurities include soapsuds, urine, blood, etc. Now whether the solid or the liquid pollution is the more dangerous to public health might be debated with great learning and little profit. But it must be admitted that the solids, or suspended impurities, are the more easily got rid of. Ordinary filtration through sand or gravel removes them, whilst the liquid or dissolved matter passes through the filter-bed with little change.

The processes which have been devised for treating sewage by precipitation are essentially of two kinds. There is what may be called precipitation simple, which was first tried when the sewage question became pressing; it consists in adding to the foul water some soluble earthy or metallic compound. Thereupon impurities seem to coagulate into denser masses, and gradually subside to the bottom. The first agent employed for the purpose, and which yet finds advocates by reason of its cheapness, was lime. Lime certainly renders the water clear, but it has many disadvantages. It leaves the water in what chemists call an "alkaline" condition (known as such by its power of turning certain red vegetable colouring matters blue). The outflowing liquid is deadly to fish—a fact of which poachers have been aware for ages. If the lime is used freely, a part of the suspended impurities are rendered soluble, and the water, if analysed, may seem to have been actually rendered worse. Lastly, the deposit or sediment produced by adding lime to water has a most disagreeable smell, often perceptible at distances exceeding half-a-mile.

Certain other substances, especially solutions of alumina and iron, such as alum and copperas, are more effective. But their higher price is an objection in this age when all other considerations are subordinated to momentary cheapness.

But to all these simple precipitation processes there is urged an objection which can by no means be at once dismissed. It is contended that "precipitation merely clarifies but does not purify," or in other words, that it removes merely the suspended impurities, leaving those of a liquid nature untouched. It has even been said that no metallic precipitant is capable of removing dissolved organic matter from solution!

This exaggerated utterance must be due to some one who, if a theoretical chemist, had but a moderate acquaintance with industrial chemistry. Otherwise he might have known that no small part of the arts of dyeing and colour-making turns on the fact that dissolved organic bodies are precipitated by means of metallic solutions, which the dyer calls mordants.

On the other hand it may be contended that the solutions of organic matter which have to be encountered in treating sewage are far weaker—and hence less easily precipitated—than the solutions of organic colouring matters with which the dyer has to deal.

We may, however, the better afford to dismiss this question as idle, since it does not in the least affect *compound precipitation*, or those processes to which we referred on p. 128 as being in principle *inverted irrigation.*

This method of dealing with impure waters (other than sewage) was known to the Chinese probably thousands of years ago. Their great rivers, which serve in extensive regions of the empire as the main water-supply are very turbid, and in this state unfit to drink. But the Chinese add to a tub of water a pinch of alum, and stir the whole well up together. On standing the mud subsides, and as it has previously absorbed the organic impurities and putrid matters, the clear water above is not only free from any offensive smell or taste, but perfectly wholesome.

It has even been found that by the joint action of an absorbent, like earth or clay, and a metallic salt, such as alum, any disease-germs present may be effectually removed from water.

This has been most strikingly proved in Annam and Cochin China. When the French first attempted to colonise these regions, their troops suffered cruelly from endemic dysentery. But after they adopted the Chinese method, and the soldiers were regularly supplied with water which had been treated with a little alum, and allowed to settle, the clear alone being poured off for use, the disease almost disappeared.

The Chinese principle was introduced into England for the treatment of sewage about the year 1868, and is now, with trifling variations, embodied in a number of processes, patented or otherwise. Clay or arable soil, with or without the accompaniment of sea-weed charcoal, waste carbon from the manufacture of prussiate of potash, and various mineral carbons is introduced into the sewage and mixed up with it mechanically, when it is remarked that the offensive odour at once disappears, the particles of earth and carbon having absorbed and become saturated with the putrescent matter. The metallic salt, which may be sulphate or chloride of aluminium, sulphate or chloride of iron, or aluminate of soda, etc., is then added, when the mixture of clay and carbon subsides, carrying down in its pores and entangled among its particles the organic matter, disease-germs, etc., whilst above it floats a clear, inodorous water, which may be safely admitted into any river. Into the details of separating the water from the sediment, we cannot here enter, especially as they cannot well be explained without the aid of diagrams.

We may, however, say that the deposit when dried sufficiently to be portable, contains nitrogen equal to 3 per cent. of ammonia, and phosphoric acid equal to 5 per cent. of tribasic phosphate of lime, being consequently much richer than any farmyard manure.

The advantage of such methods of precipitation is that whilst they are thoroughly efficient in a sanitary point of view, and whilst they recover the greater part of the manurial matters, they require but little space and can be adopted, where from the peculiarities of the soil and the climate, the high price of land, the populous character of the neighbourhood, etc., it is not practicable to lay out an irrigation-farm.

In many places, where the sewage is rich and where high farming prevails in the neighbourhood, the sale of the manure may to a great extent cover the cost of treating the sewage. It will not, however, yield a handsome profit over and above such cost.

Hence, if there were no necessity for the treatment of sewage, if polluted rivers were not injurious to health, and if their waters could be used without injury in the arts and manufactures, then we should say that sewage-irrigation farming, and in like manner the manufacture of manure by precipitation processes, were poor, very poor investments. But as we are compelled to purify the sewage, the only practical question is, Shall we adopt those methods which yield no return whatever, or rather methods by which we may be, in part at least, recouped for the expense incurred?

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## A JUBILEE RETROSPECT.

WE commend the following extracts from the *Times'* "Jubilee Retrospect," to all who have not already seen it:—

The keynote of the Victorian era is the development of scientific research, the concomitant growth of practical invention, and the expansion of industry which these have brought about. Other ages have been fruitful of profound scientific conceptions, or have been illustrated by great inventions and discoveries; but it would be difficult to point to any half-century in the history of the world in which equal progress in speculative science has been combined with anything approaching to the magnitude, variety, and importance, of the applications of science to practical ends which distinguish the present reign. It is as true to-day as at any former period that nothing great can be done in pure science save by men who make the discovery of truth the sole aim of their efforts and who prize no other reward. But it is no less true that abstract and applied science go hand in hand as they never did before, and that each owns enormous obligations to the other. For if the triumphs of the workshop have been achieved by means of the discoveries made in the laboratory, on the other hand the laboratory depends for every step of its advance upon the technical skill and hitherto unrivalled precision of the workshop. Physical science has reached a stage at which the verification of its hypotheses and the supply of new data for its speculations demand appliances of extraordinary excellence, and in many cases a collation of experience and experiment which nothing but the practical inventions of the age could render possible. It is doubtless to the co-ordination of the two forms of intellectual activity that we owe the rapidity of recent advance. An unprecedentedly large army of enquirers has simultaneously pushed the interrogation of nature in a thousand directions, and has attained unprecedented results. But beside them has been working an army larger, and equally keen, of men eagerly seeking to utilise for practical ends every crumb of available information, and giving to scientific ideas a concrete application which often forms the starting-point for new processes of scientific induction.

The fundamental conceptions of the material universe entertained by educated men have been revolutionised during the last fifty years. The simple atomic theory of the older chemistry has given place to a molecular theory, which itself has undergone considerable development. The outlines of the elements which the older chemistry accepted as an ultimate analysis are melting under the gaze of the spectroscopist, who across the haze of their wavering figures catches glimpses of a simple primal matter. The evolution of matter is, however, like the evolution of living forms, a philosophical conception which must always rest rather upon the general necessities of thought than upon actual experiment. The immutability of certain forms of matter in all the conditions that we can devise or have any experience of is as absolute as the persistence of specific types in the animal or vegetable kingdom. The most refractory substances have been vapourised in the electric arc, and the most attenuated gases have assumed the solid form under the combined influence of intense cold and enormous pressure. But we have made no nearer approach to actual evidence, either of material evolution or of the complexity of the so-called elements, than may be inferred from certain spectroscopic observations of the sun, and some experiments tending to show that in some cases we have confounded two or more very similar elements under one name. Apart, however, from these abstruse speculations, the whole tendency of physical and chemical investigation has been to bridge the gulf formerly fixed between molar and molecular motion and between chemical and mechanical force. There is an obvious interdependence between this scientific movement and the doctrine of the conservation of energy, which is one of the main philosophical achievements of the epoch under discussion. According to that doctrine, the total energy of any body or system of bodies is a quantity as absolutely fixed, and as incapable of suffering either increase or diminution, as the matter of which these bodies are composed. Energy, like matter, may assume an endless variety of forms; but the force put forth by the locomotive is as indestructible as the particles which compose its framework or its fuel. But to balance our account we have to take cognisance, not only of the forces of impact or pressure of which we have direct experience, and conceive ourselves to have tolerably full understanding, but also of the forces of attraction and repulsion in their various forms, concerning which we as yet know absolutely nothing beyond the fact of their existence as inferred from their effects. To refer the whole complex sum of these energies to a general law, and to deal with them on fundamental physical and mathematical principles is the aim of the physical science of to-day. Notwithstanding all superficial resemblances, it stands differentiated from the science of all past ages, by the clearness with which it apprehends the nature of this quest, and the unrivalled range of the analytical methods it has brought to bear. In the domain of biology the theory of evolution first placed upon a scientific basis by the genius of Darwin, is a product of the same great movement of philosophic thought which brought forth the molecular theory of matter, and the doctrine of the conservation of energy. The idea of evolution itself was not new; but what was new was the proof that in the vast geological changes established by the labours of Lyell and other workers in the same field, in the visible tendency to variations in existing plants and animals, and in the evidence, collected by Darwin's industry and observation, of the power of the struggle for existence to exercise, in given conditions, a selective and protective influence upon occasional variations, we have all the data required for the construction of a coherent theory. Evolution has now definitely taken its place as a working scientific hypothesis, not, indeed, capable of explaining all the facts of biology, but consistent with these facts, and furnishing—the most that a scientific hypothesis can ever do—the means of systematising our knowledge in preparation for a further advance. The study of embryology is already modifying profoundly the interpretation put upon the evolutionary theory, and is probably paving the way for some new generalisation. Mr. Herbert Spencer's application of the theory of evolution to the facts of social order is the expression, in the sphere of human thought and action, of the intellectual movement of which Darwin made himself the exponent in the field of biology.

## VORTEX RINGS.

PROFESSOR THOMAS ESRICHE, of the Bilbao Institute, has communicated an interesting article on the above subject to *La Nature*, and we are indebted to our contemporary for the illustrations with which this article is accompanied. Professor Esriche remarks that all who have learnt a little chemistry will doubtless remember the interesting experiment of making vortex rings by letting phosphoretted hydrogen (mixed with traces of another compound of phosphorus and hydrogen) escape into the air from water. As this curious phenomenon evidently did not depend on the peculiar properties of the gas, he for a long time sought means of producing it with tobacco smoke, and even with some chemical precipitates which are a kind of smoke in liquid. After some failures he succeeded, and, briefly, this was his *modus operandi.*

He took a little hydrochloric acid in a pipette, and let drops of it fall into a very weak solution of nitrate of mercury. Rings of chloride of mercury were then formed, and they had a vortex movement similar to that which characterises the rings formed on the combustion of phosphoretted hydrogen. The drops of acid must fall slowly, and from a point near the surface of the liquid. The same result can be obtained in other solutions, provided the precipitate is not too thick, as rings would not then be formed. Even milk can be used, if drops of it are allowed to fall gently in a glass of water.

As to rings of smoke, these can easily be made by puffing smoke from a cigarette through a tube, as in Fig. 1. Some precautions, however, are necessary to insure success; for instance, all currents of air must be prevented. For this purpose, windows and doors should be closed, and to prevent ascending currents being produced in proximity to the body of the operator, it is desirable to make the experiment over a table, as shown in Fig. 1; the rings will not then be appreciably affected by currents of warm air. A tube two centimetres in diameter, made by rolling a sheet of ordinary note-paper, answers very well for rings three or four centimetres in diameter at the outlet of the tube.

Fig. 1.

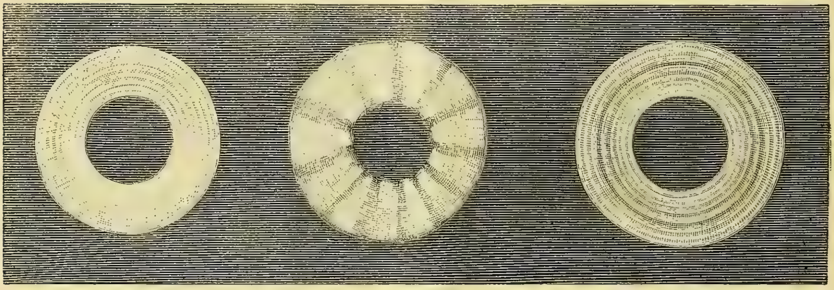

Fig. 2. Fig. 3. Fig. 4.

To observe the rings well, it is best to direct them towards the darkest part of the room, or towards a black board. The first puffs of smoke will not produce rings unless the tube has been previously filled with smoke. The vortex movement is easily seen at the outlet of the tube, and even at some distance beyond it.

As to the appearance of rings sent with more or less speed to various distances, the Figs. 2, 3, and 4 give a tolerably clear idea. The Figs. 5 and 6 show how the rings lose their shape when the surrounding air is quiet; they have the appearance of filaments of smoke falling downwards with a kind of little hood at the lower part. These curious forms of smoke are especially well seen when beams of sunlight are admitted into the room across their path.

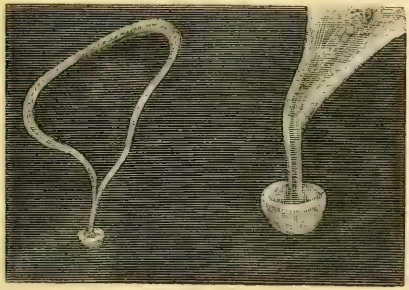

Fig. 5. Fig. 6.

## THE TINTOMETER.

THIS instrument is used for the purpose of comparing the depth of colour of a liquid or solid with a standard scale of colour, so that the substance to be tested may have its colour measured in degrees of a colour scale. On referring to the accompanying illustrations, it will be seen that Fig. 1 is a small perspective view of the apparatus, and Fig. 2 an enlarged sectional view. The box encloses two tubes, side by side, but not parallel, which are separated by a partition F. Both the tubes are open at AA, and at C there is an eye-piece, which enables the operator to see at the same time and under similar conditions the standard colour D and the colour ED which is to be compared with it. The standard of colour is formed by choosing a glass slide faintly tinted with the colour to be standardised, and if this be considered a single unit or degree of colour, a scale is easily built up by adding successive units


Fig, 1. The Tintometer.

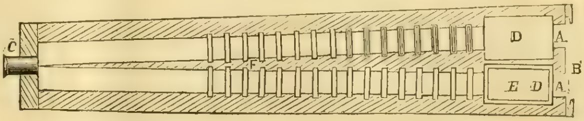


Fig. 2. Enlarged Sectional View.

of the same colour. It is best to base the unit of colour on a percentage solution of some known substance, so that it can be checked or repeated at any time. The principle of the instrument will doubtless be readily understood, and its application, in the way described, to industrial purposes is certainly ingenious, and bids fair to be very useful. For instance, brewers can use it for ascertaining the colour of pale malts before they buy them, and for finding the colour value of highly dried malts. They can also watch the increase or loss of colour during the processes of manufacture. It is also suitable for determining the colour value of dyes, and for watching the loss and change of colour under the influence of light. In the analysis of water it is also useful as a means of finding the degree of colour and turbidity. Many other applications of this instrument might be mentioned, but those we have referred to are sufficient to indicate its simplicity and usefulness. We may add, however, that it affords a ready means of testing the degree of colour blindness, and of comparing the sight of two eyes. The maker is Mr. J. W. Lovibond, of Salisbury, and the instrument can be seen in the Chemical Section of the Manchester Exhibition.

## THE TELEPHONE: ITS PRINCIPLES, CONSTRUCTION, & APPLICATION.—II.

IT has now been shown that the Bell telephone is competent to act both as a receiving and transmitting instrument, and that speech can be exchanged between distant points without other apparatus. Practically, however, the Bell instrument is not sufficient for commercial use. The received sound is extremely feeble, and conversation can only be carried on in a very quiet room. Quiet rooms are out of the question in most offices and shops, and in factories are quite impossible. The feebleness of the Bell instrument is due to the fact, that only a small fraction of the total energy in the original sound-waves can be utilised by the small diaphragm (and it is not found that larger diaphragms improve matters), that there is more or less loss in every transformation experienced by the original energy, that energy is lost in the conducting circuit in the shape of heating of the wires, and in the mechanical and magnetic work done in both the transmitting and sending instruments. The loss in the line is directly proportional to its length, and is dependent on the size and material of the conductor. An iron wire gives about six times as much loss as a copper one of the same size, and a wire, one-twentieth of an inch in diameter, four times as much as one a tenth of an inch in diameter, other things being equal. The working current being so small as to be hardly measurable, stray currents from telegraph wires, electric light circuits, or earth currents, interfere with speech, and drown the weak voice of the receiving instrument; and this suggests that, before leaving the Bell telephone, it ought to be said that it is such a sensitive instrument to intermittent, alternating, or vibratory currents, that it has been largely used as a laboratory instrument in investigations in which such currents are used, and that it has done excellent service in the hands of several scientists, chief among whom should be mentioned Professor Hughes, who has used the telephone in his researches on magnetism with most interesting and useful results.

Now, it being proved in the first place, that an electric current can be used to convey articulate sounds, and in the second place, that the currents generated directly by such sounds are too feeble for practical purposes, it soon suggested itself to a number of people that the sound vibrations might be used to control currents produced by batteries, or other powerful sources of current. Just as a man, or even a boy, can control the motion of a steam-engine, giving out as much power as hundreds of men, and can direct that power into various useful channels according to the requirements of his work, so it occurred to some people, that the vibrating diaphragm of the transmitting telephone might be made to control the flow of a much more powerful current than it could possibly generate. This was, in fact, the first idea of a telephone, and it was embodied in Reis's instruments as early as 1861, and a Frenchman named Bourseul in 1854 had the same notion, but went farther than vaguely hinting at it. The idea is derived from the Morse telegraph apparatus, which in its simplest form, that of the "single current sounder," consists of a galvanic battery, a key arranged to make or break the circuit of the battery, and an electro-magnet placed in that circuit and arranged to attract an iron amature, whenever excited by the current from the battery. Part of the circuit consists of the line wire. The battery and key are at one end of the line, and the electro-magnet (which, with its armature and necessary fittings, is called the "sounder") at the other. The circuit is completed through the earth. In any electric circuit a current can only flow when the circuit is complete, that is, when the conducting line from one pole of the battery to the other is complete. The "key" gives the means of completing or breaking the telegraph circuit, and in its normal position the circuit is not complete. When the key is pressed down the circuit is closed, a current flows through it, including of course the sounder, the armature is attracted and kept down as long as the key "makes contact" or closes the circuit. The sending telegraphist is thus able to send a succession of currents of various lengths, and to rap out on the sounder "dots" and "dashes" which spell out

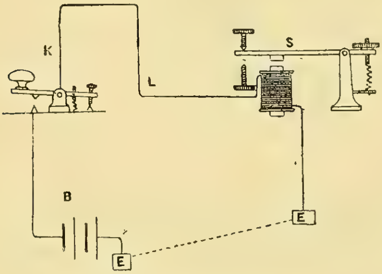


Fig. 4. Morse Sounder Circuit.

letters and words in the telegraphic alphabet. Figure 4 is a diagram of a Morse Sounder Circuit as described. K is the key, shown in its normal position, the spiral spring holding it in the breaking contact position, L is the line wire, B the battery, and S the sounder, with the armature held away from the electro-magnet by the opposing spring. In practice, there is a key, battery, and sounder at each end of the line, and the back contact which the key lever rests on is connected to the sounder, so that there is always an unbroken circuit, but without a battery to produce a current in it, until either key is depressed, when the sounder at that end is thrown out, and the battery thrown into circuit.

If we make the key, K, very light and attach it to the centre of a diaphragm like that of a Bell telephone, then it can be easily seen that sound vibrations striking the diaphragm with sufficient force will complete the circuit at a rate corresponding to the number of vibrations characteristic of the sound. This number of short currents will flow through the circuit, and each magnetising the electro-magnet of the sounder will set up a vibration in the armature which will produce a musical note of the same pitch as the one actuating the key. It will be readily understood that the key, or, as we may now call the combined key and diaphragm, the transmitter, must be so adjusted that with normal air-pressure on the diaphragm the circuit is broken, and with certain higher pressure the circuit is closed, then every time the pressure due to a sound wave rises above that point contact will be made, and every time the pressure falls below it contact will be broken. If, then, a complex sound wave acts on the diaphragm, the current cannot correspond to its complexities, only the crests and hollows of the wave, so to speak, will be represented, and the wavelets which give to sounds their various characters cannot be transmitted by an instrument which makes and breaks contact, though for simple musical sounds the instrument may transmit fairly well. The receiver, to give audible sounds, should be arranged so that the vibrations may be imparted to a fairly large surface, and the best receiver is the Bell in one of its many varieties.

It will be seen that any battery power, and therefore any current strength that will not injure the apparatus can be employed, and that therefore the receiver can give out much more audible sounds than if actuated by the feeble current from a Bell transmitter.

So far, however, we have only got a transmitter for comparatively simple sounds, and one that will not transmit the delicate gradations of current representing the ripples and wavelets of articulate speech. It is like an engine throttle valve, which can only be at the "shut off" or "full open" position. The driver with such a valve could only stop or go at full speed. It is evidently necessary to have a transmitter that will do more than make and break the circuit, it must be capable of making a more or less complete contact, or, as an electrician would put it, must introduce more or less "resistance" into the circuit. This can easily be managed. It is found that when an electrical circuit is made through the contact of two conductors, the resistance offered by that contact depends, other things being equal, upon the pressure forcing them together. The greater that pressure, the lower the resistance and the stronger the current flowing across the contact. The exact reason for this is still a matter of dispute among experts, probably a number of actions are concerned, but it is easy to understand that the number of points actually in contact, and therefore the number of roads open to the current, must correspond to a certain extent with the pressure between the two surfaces. This action is probably the most important one concerned.

To enable a diaphragm, when spoken to, to communicate all the gradations of pressure on it to a pair of contacts, both contacts should be elastically mounted.

Philipp Reis saw this, and in his first transmitters acted on the principle. He took the human ear as his model, holding the opinion that as the outer ear certainly received all audible sounds, and transmitted them to the nervous system of the inner ear, the mechanical arrangements of the ear formed a good model for an electrical ear. In the ear we find a diaphragm (*a*) (the tympanic membrane) at the end of a tube (*b*); connected with the centre of the diaphragm (*a*) is a little bone (*c*), forming one of a chain of three, the other end of which is connected with a membrane (*d*) stretched across the opening of a canal (forming one of a system of canals in the bone of the skull), filled with a thin liquid, which bathes the nervous arrangements. The whole of this is shown diagrammatically in Fig. 5, and it will be seen that the transmission mechanism is all elastic, but cannot come apart, or "break contact."

Reis followed this plan in his transmitters by making the contacts springy or mounting them on springs, by which means, as the diaphragm moved inwards under pressure, while it encountered no rigid resistance to its motion, the pressure between the contacts increased or diminished in a way which bore a definite relation to its position at any

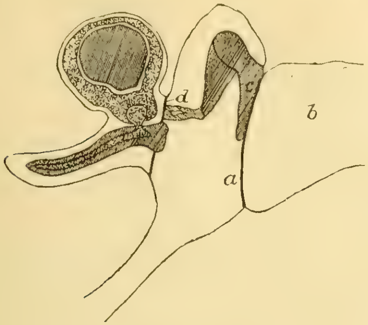


Fig. 5. Tympanic Membrane of Human Ear.

moment, and therefore the electrical resistance of the contacts varied with the variations of air-pressure due to the sound waves. It is interesting to know that Reis copied very closely the actual form of the human ear in his first transmitters, even carving the mouthpieces into rough copies of the external ear.

The transmitter shown in Fig. 6 is chosen for its clear representation of the various essential parts of Reis's transmitters. It was neither the earliest nor the latest of the many patterns he made, but has the characteristic features of all his designs.

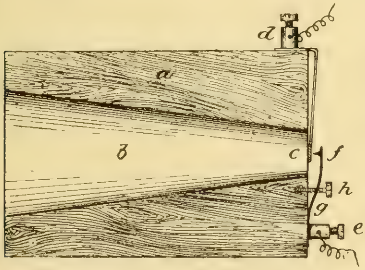


Fig. 6. The Hollow-cube Transmitter.

Figure 6 shows a sectional view of the "hollow cube" form of transmitter. The rectangular wooden block (*a*) has a conical hole (*b*) bored through it from end to end, forming the mouthpiece. Across the smaller end of this hole is tightly stretched a diaphragm made of the intestine of a pig (probably a piece of sausage skin), and marked *c* in the figure. Two brass terminals, or binding screws, are fixed into the block at *d* and *e*, and two strips of thin springy brass start from each terminal and meet outside the centre of the diaphragm at *f*. The one from the upper terminal rests lightly upon the diaphragm, and carries a little button of platinum. The strip from the lower terminal carries a little spike of platinum resting on the platinum button, thus forming a spring contact, the pressure on which is under the control of the diaphragm. The lower brass strip has a screw (*h*) passing through, and this serves to adjust its tension. To the terminals *d* and *e* wires are attached, putting the instrument in circuit with a battery and a telephone receiver. When the diaphragm is put into vibration by sound waves, it will vary the pressure between the contact point in a way corresponding to the pressure acting on it, and if the tension of the strips is well adjusted to the loudness of the sound, the contact will not be broken, their springiness allowing them to follow the diaphragm in its excursions. As already explained, the current in the circuit will vary with the varying pressures on the contacts, and the sound waves will be reproduced in the receiver, which may be a Bell telephone, or one of Reis's own designs. The principal features in which Reis's transmitter resembles those most used at present are—1, The employment of a diaphragm to gather the sound waves, and concentrate them upon the "loose contact"; 2, Mounting the contacts on springs, so that they may follow the vibrations of the diaphragm without breaking contact. The chief feature of difference is in the use of metallic contacts, most transmitters in commercial use employing carbon contacts. It has been found, however, that some metallic contacts act very well, the chief objections to them being their liability to fusion, and oxidation, and the extremely fine adjustment necessary, owing probably to the small compressibility of the small points forming the surfaces. Reis used the most infusible metal, one which does not oxidise when an electric spark passes between the two points, and is therefore one of the best metals that can be used. The infusibility of carbon and its higher specific resistance, enabling a larger surface of contact to be used, with a more gradual variation of contact resistance, and less necessity for extremely delicate adjustment, are the advantages which have determined the all but universal use of carbon contacts for variable resistance transmitters.

With regard to the second point Reis always speaks of "making and breaking" the circuit in a way corresponding to the sound waves, and it has been argued that he had no idea of the necessity for avoiding complete breaks, and making the current strength vary in a wavelike or undulating manner. The construction of his instrument, his written explanations and diagrams of sound waves, scarcely bear out this contention, and as there is no doubt that his instruments transmitted and received speech (perhaps not very perfectly), Reis must in fairness be credited with the invention of the speaking telephone. We must just look for a few moments at Reis's receiver, as it is original and ingenious in conception, though superseded by the Bell now.

In 1837 Page discovered that an electro-magnet gave out a click whenever the magnetising current was either started or stopped; and it was found on investigation that the iron of an electro-magnet was lengthened to a very slight extent upon magnetisation, and attained its original length on the stoppage of the mangetising current. The change of length is no doubt the cause of the click. Reis took advantage of this effect. His receiver shown in Figs. 7 and 8 consisted of a coil of insulated wire *a*, a thin wire of iron or steel, forming the core of the electro-magnet *b*, resting on wooden supports something like two violin bridges, glued to the top of a shallow box made of thin wood. This box strengthens the vibrations of the iron in the same way as the body of a violin reinforces the string vibrations. In fact Reis in his earliest instruments used a violin body, first sticking one end of the iron wire into one of the *f* holes of the violin, and afterwards attaching one end to the bridge of the violin. The way in which this instrument converts an undulatory current into sound waves is obvious, the lengthening and shortening of the iron throwing the box into vibration, so that in this instrument the flat top of the box played the part of the diaphragm in the Bell receiver. It is a little curious that Reis should never have tried a diaphragm in his receivers, but such seems to have been the case. The only form of receiver he seems

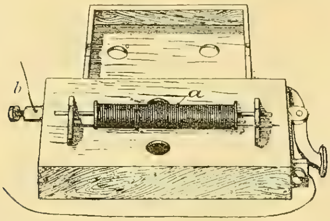


Fig. 7. Reis's Receiver.

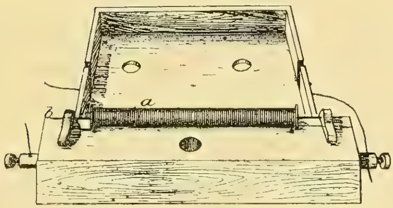


Fig. 8. Reis's Receiver.

to have made with an armature consisted of a horse-shoe electro-magnet, attracting a light iron armature carried on a thin wide vertical wooden bar, suspended from a metal upright by means of a stretched wire running across it. A screw served to adjust the position of the armature, and a spiral spring opposed the magnetic pull. The instrument is much like a telegraph sounder laid on its side. The idea evidently was that the vibrations of the armature would be communicated to the air by means of the broad wooden bar. It does not seem that this receiver worked very well. Probably the suspended armature behaved like a pendulum, and was only sensitive to waves corresponding to its own vibration rate, or to multiples of that rate.

(*To be continued.*)

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## SPONTANEOUS COMBUSTION.

THAT the outbreak of fire in dwellings, warehouses, manufactories, etc., is, in most cases, due to human carelessness or malice needs no demonstration. Still it is a matter of experience that certain substances are capable, under well-known circumstances, of becoming spontaneously heated until they ignite and communicate fire to any combustible matter which may be near them.

The simplest illustration of this fact may be found in the pneumatic tinder-box—an instrument for obtaining fire and light far too inconvenient for practical use, but curious and instructive in its principle. A well-fitting piston is made to work in a brass cylinder, at the bottom of which is laid a little tinder. The outside of the cylinder is covered with some non-conducting material, and if the piston is then forced down with sufficient rapidity the tinder is ignited by the liberation of heat from the air on compression.

But a condensation of air can be effected without any mechanical force being employed. Many kinds of organic bodies, if in the state of thin films, fibres, or fine powder, condense air upon the surface of each particle. It need not be said that this is a very favourable condition for oxidation, and in case of any combustible body combustion is merely oxidation rapidly effected, so that the heat generated is manifest to our senses.

Perhaps the most familiar instance of the spontaneous combustion of fibrous organic matter is that occasionally seen in hay-ricks. In rainy summers, when the sunshine and wind have not sufficed to dry the hay, and when the farmer has been too "penny wise and pound foolish" to accept the safety offered by the Gillwell drying machine, it is often noticed that a rick begins to steam and gives off a peculiar smell. If these symptoms are neglected the steam and the smell increase, and ultimately the mass bursts out into flame, or at least smoulders away, leaving only a charred and blackened residue. Heaps of tanners' bark fire in a similar manner, and if precautions are taken for regulating and limiting their heat, they serve, like horse-dung, for supplying "bottom-heat" in forcing-pits, cucumber and melon frames, etc.

Ground dye-woods—especially logwood—if stored up in bulk in a damp condition at dye works, drysaltery warehouses, etc., are liable to "heat," as it is technically called. Here a temperature far below visible redness renders the wood utterly useless. It is further noteworthy that logwood, when once it has begun to heat, can scarcely ever be cooled again. It may be spread out to the air and the mischief to all appearance may be stopped. But as soon as it is collected together again in a heap the heating returns.

Now, in all these cases we have certain points in common: organic matter in a fibrous or powdery state and a large proportion of moisture. Blocks of logwood and heaps of unground tanners' bark will not heat however long they may be exposed to damp air; they simply moulder away. Neither does dry hay, dry bark, or dry logwood, though finely ground, rise in temperature. Thus, paradoxical as it may sound, water is here a cause of fire. Where there is not fine division little surface is exposed to the action of the air, and where there is little or no moisture chemical changes are suspended.

Another cause of spontaneous combustion, far from rare in manufacturing establishments, depends on the changes which oils and fats of animal or vegetable nature undergo when exposed to the air. This also depends on the absorption of oxygen. If such oils and fats are present in masses, this absorption is slow; no heat is felt, and we perceive merely the gradual production of rancidity. But if the oils are spread out in thin layers over large surfaces the conditions for combustion in the popular sense of the term are at hand. These conditions are perhaps most fully realised in cotton waste, as it is used for wiping the working parts of machinery. A handful of such waste, saturated with grease, is carelessly thrown aside, and happens to fall upon or close to shavings, raw cotton, paper, or other matter easily liable to ignition. The film of oil coating every fibre of the waste absorbs oxygen, heats, and finally inflames the cotton, and there is the tiny seed of a mighty conflagration.

There is, perhaps, no material known so suitable for fitters, engine-minders, etc., to use in cleaning machinery as cotton-waste, and if due care were always taken to throw it, when done with, upon some non-combustible substance no harm would result.

Even wool and woollen rags, though much less inflammable than cotton, are capable of spontaneous combustion if soaked with oil.

We must here glance at a popular error. Petroleum and the mineral oils generally are much more readily kindled than olive oil, linseed oil, etc. They are able to burn without a wick at comparatively low temperatures, whilst the animal and vegetable oils have to be heated to a boil before they will take fire. But for all this, petroleum and its tribe are less capable—or we might say incapable—of spontaneous combustion. If exposed to the air in their films they undergo, practically speaking, no immediate chemical change. Hence cotton-waste saturated with such oils will not ignite spontaneously, ready as it is to blaze up on contact with a spark. Petroleum has its faults, but there is no need to accuse it of imaginary sins.

Of all textile fibres silk is the least liable to chemical changes. It will not putrify or decay; it can be made to burn only with great difficulty, and it is, as furnished us by Nature, utterly incapable of spontaneous combustion. It is very little disposed to condense upon its surface and to absorb gases and vapours, and to take up smells. Hence it is the safest material for the dress of persons exposed to infections. But these properties joined to its low conductive power for heat and electricity—the very properties, in short, which render it precious—are now systematically destroyed at the instance of modern greed and the outcry for cheapness. There has sprung up a practice known as "loading" or "weighting." The depraved ingenuity of the dyers has succeeded in converting a pound of silk into two or even three pounds of a something which possesses none of the properties of silk, chemical or physical, but which may at any rate be sold as silk to the loss of the consumer. Now these weighted silks are decidedly capable of spontaneous combustion. Sometimes they have been known to break out into ordinary open combustion. Sometimes they have been known to smoulder away to ashes without any visible fire. In a case of this kind an insurance company was compelled by a French Court—most unjustly, in our opinion—to pay the sum claimed by a warehouseman who held an ordinary fire-policy. We should advise all insurers, railway companies, ship-owners, etc., to be on their guard against this very unsafe material.

Fires may also be produced if strong acids—in particular nitric and sulphuric—happen to leak out upon straw, saw-dust, hay, or the like. These acids are generally conveyed in carboys packed in hampers, and hence they rank among the many substances much better adapted for water-carriage than for conveyance by rail.

In a few instances premises have been set on fire by articles capable of acting as burning-glasses, and thoughtlessly left where they might bring the sun's rays to a focus upon some readibly inflammable matter. Decanters filled with water, if made of very clear glass and of a form approaching the globular, can thus act as convex lenses. It is true that in England clear, prolonged sunshine is not so common as to bring this source of danger to the front. In the sunny regions of Australia, South Africa, etc., there is a much greater chance of accidents of this kind.

Panes of glass with convex knots in them were at one time commonly used for the windows of sheds, out-houses, workshops, etc., and such may still be seen in old buildings. We have seen a piece of blackened paper ignited in the focus of one of these knots, whence they must evidently be set down as dangerous. At the present low prices of glass there can be no reason for their use.

Another cause of mysterious fires is of a more sudden and perplexing nature. Every one knows that a chip of wood will not take fire at the heat of boiling water—212° Fahrenheit. It must either be heated very much higher or be brought in contact with a flame. But if wood is exposed for a long time to the temperature of boiling water it gradually undergoes a series of changes which render it much more readily inflammable. It may, indeed, in such cases ultimately take fire without the approach of a flame. What length of time is required to bring about these changes has not hitherto been satisfactorily determined, but it is probably one of months, if not years. Nor are we able to lay our hands upon any precise answer to the question whether a continuous or an intermittent heat is most likely to bring on this result. Alarms of fire, we understand, have occasionally been raised in churches, museums, libraries, and other places heated by means of hot-water pipes, and in other instances, on repairing such buildings, wood-work which had been in immediate contact with the pipes was found to be much altered in appearance and texture, and to have been rendered very easily inflammable.

A few practical precautions are therefore necessary in laying down systems of heating pipes. The metal should rest not upon wood but upon a bed of glass-wool, asbestos, or similar material placed on a slab of stone or stoneware. Above all, no sawdust, shavings, or chips should be left near the piping.

It is scarcely necessary to say that steam and hot-air pipes present exactly the same risks and require the same precautions.

The reader will naturally ask whether the forest fires which cause such devastation in semi-tropical countries may ever be due to spontaneous chemical action, fostered by intense and prolonged heat? As a rule these calamities do not happen "without hands." A traveller drops a match, not caring or not knowing whether it is extinguished or not. It happens to fall upon some dry moss, or some withered and perhaps resinous twigs of underbrush, and the thing is done!

Still, if this is the *common*, we suspect it is not the *exclusive* history of the birth of a bush fire. Water placed in a blackened vessel, behind which is fixed a reflector, may be raised to the simmering point on exposure to an Australian sun. Now it seems to us probable that mosses and other finely-divided vegetable matter may, after being thus exposed day by day to the sun, be gradually brought into that state of ready inflammability of which we have just spoken in the case of woodwork in contact with hot-water pipes. Of course, the conditions for such an accident may very rarely coincide. It is only when suitable materials are collected together in sufficient quantity and lie fully open to the sun and screened from the wind that the heat of the mass can rise to the ignition point. But judging from what is known, given these possible conditions, the result is, at least, possible. To prove a negative by demonstrating in any particular case that no person could have dropped a match is, of course, impossible.

It would be interesting to make an experiment in some place where no harm could accrue, and carefully note the rise of the thermometer and the other phenomena produced.

It would take us too far were we to enumerate all the substances which may possibly take fire spontaneously, with or without explosion. We will only mention one class of such bodies—the mixtures for coloured fires as used by pyrotechnists. Some of these, if prepared in quantity and kept in stock for some time, have been known to become ignited. Hence, follows the practical conclusion that fireworks should not be manufactured or even stored in quantity in any building situated near to dwelling-houses or to public thoroughfares. It is not pleasant to reflect that your property and your person may at any moment be placed in jeopardy by a slight oversight on the part of a neighbour.


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ZOOLOGICAL · STUDIES · AT · THE
AMERICAN · EXHIBITION · BY · R · E · H ·

## ZOOLOGICAL NOTES AT THE AMERICAN EXHIBITION.

OF great zoological interest is the collection of mounted heads and horns, etc., forming part of the American Exhibition at Earl's Court, as it gives to the scientific zoologist and the collector a rare opportunity of making those comparisons which are so necessary to estimate the relationship of certain more or less fixed zoological characters; for, as is well known, it is only by the comparison of numerous examples or specimens that it can be correctly ascertained how far they can be relied upon for systematic purposes; if they vary, in which direction, whether by excess of development in the case of very many pointed horns where the normal type is simple, or by arrested growth (except by accidents), as in the case of unequally developed horns, on the same head. Such a collection as this enables us to ascertain how far our museums (whose teaching value is so tardily recognised) have fairly representative examples for the purposes of comparison. We may also here obtain a few additional notes as to the geographical distribution of some of the species, methods of preparation and of preservation, as well as a case or two of comparative pathology.

Our page illustration contains a selection of seven noteworthy or representative heads, all drawn from the specimens. Probably the most remarkable head which strikes us on entering the room is the

ELK (*Alces machlis*), or moose, No. 1, of which there are eight or ten good examples, the finest being exhibited by Mr. Otho Shaw. The weight of these gigantic horns must indeed be very great, and proof is supplied to us by the great development of the spinous processes of the cervical vertebræ, to which are attached the strong muscles which sustain the weight of head and horns. The length of the horn from base to tip is 35½ in. The circumference of the beam is 8½ in.; extreme width, 39½ in. Another remarkable and unique Elk's head is that of Mr. Bierstadt's, which has been specially sent across the Atlantic for comparison. The breadth and weight of these antlers is enormous. The geographical range of the Elk is now almost exclusively confined to Alaska, portions of N.E. United States, Nova Scotia, and New Brunswick, though there are abundant proofs of their range having been much wider. A fine male Elk will attain six feet at the withers. There are now alive at the Zoological Society's Gardens a good male and female.

THE WAPITI (*Cervus canadensis*). No. 2.—The Elk of the American squatters. There are fifty fine heads of this noble stag on view, and the critical acumen of the judges must have been sorely taxed in selecting the best, but as no head contains *all* the "points of beauty" they have made a selection of twelve of the most remarkable and magnificent Wapiti heads ever brought together, of which accurate measurements are given. The two finest are Mr. Cooper's and Mr. Baillie Grohman's. The length of horn in the former specimen is 62½ in., circumference at base 8 in. In the latter specimen the length of horn is 60 in., and 7⅞ in. at base; both have twelve points. Mr. Seton-Karr and Mr. Tulloch exhibit superb heads, the latter specimen having no less than twenty points. That these noble animals, in common with others in the same room, are on the highway to extermination is a matter for thought and of regret, but like all other animals which have natural embellishments, they are marked out by hunters, collectors, and others either as trophies to prove their prowess or to supply an ever-increasing "commercial" demand for horns and fur. The Wapiti at present inhabits the mountain districts of Pennsylvania, Virginia, Minnesota, Dakota, Oregon, and California, but not beyond 57° N. There is a fine pair now living in the Zoological Gardens.

THE CARIBOO, OR WOODLAND REINDEER (*Rangifer tarandus*). No 3.—Only a few examples of the horns of this interesting deer have been obtained. Those exhibited by Mr. Norman Lampson, from one of which our sketch was taken, are the best. They do not attain to the massiveness or length of the Wapiti, but they have nevertheless points and characteristics peculiarly their own. There is no one of the *Cervidæ* whose horns differ so much, not only individually but collectively, as the horns of the Cariboo. Points spring out from the palmated "brow" tine, and at the extremity of the beam, which is also palmated, in an extraordinary, and, to the zoologist, in a perplexing manner. One or other of the brow tines in this species is invariably absent or developed as a small snag only, the corresponding tine growing well forward with a broad spatulate end, from which spring lesser points. The females bear horns. There are now living in the Zoological Gardens a very good pair of these animals.

WHITE ROCKY MOUNTAIN GOAT (*Haplocerus montanus*), No. 4, of which there are three or four heads and three entire mounted animals, is doubtless the rarest species shown in the Exhibition. It is a little larger than our domestic goat, with a singular hump over the shoulders, long white hair, very abundant about the neck; the horns are black and short, and slightly ringed at the base, but do not exceed 8½ in. long. It inhabits the almost inaccessible crags and cliffs in Western Montana, Idaho territory, and in British Columbia, where it is said to be most plentiful. It has never been brought alive to this country.

VIRGINIAN, OR WHITE-TAILED DEER (*Cariacus Virginianus*).—The two smaller species of American *Cervidæ* are here well represented by good examples of heads and horns. Of the Virginian deer (No. 5) there are seven or eight specimens. The absence of the brow tine, and the singular forward direction of the upper part of the antler, are characteristic; the horns are small, and the tines seem to grow from the back of the main beam.

Several examples have from time to time been obtained by the Zoological Society, and a male is now living in the Gardens.

PRONGHORN ANTELOPE, OR PRONG BUCK (*Antilocapra Americana*).—This singular animal is well represented by about a score examples. Our sketch (No. 6) gives a good idea of the head and horns. Its habitat is Western United States—from Mexico north to British Columbia. At one time it was very common in California and Oregon territory. A fine head is exhibited by Mr. Otho Shaw, of which the horns are 15 in. long. A singular fact in reference to the shedding of horns is that, though this animal is a hollow-horned ruminant, it annually sheds the upper portion of its horn, like a solid-horned deer. A good specimen was obtained alive by the Zoological Society about five years ago.

BIG HORN, OR MOUNTAIN SHEEP (*Ovis montana*).—There is a grand series of over thirty heads from which to compare and make notes of. Our sketch (No. 7) gives a good idea of one of Mr. G. Buxton's. The horns in this species do not curve so much as the Indian or European species. They are, however, very massive and of great weight. The Big-horn is excessively wary, and it needs indomitable pluck, endurance, and patience to get at them. The length round the horn in the specimen drawn is 36 in., and circumference of horn at base 14 in. "Big-horns" are found in the mountainous districts of Upper Missouri, Yellowstone, Mauvais Terres, and westward to Oregon and California, and southward into some portions of Mexico.

## PHOTOGRAPHY BY MOONLIGHT.

IN our July number we gave examples of photographs taken by moonlight, and one of them represented the path of the moon during an exposure of one hour. Mr. James Jackson, the secretary of the Geographical Society at Paris, has now sent us a very interesting photograph taken by him during a partial eclipse of the moon on the night of the 3rd August. The exposure lasted two hours and twenty-one minutes, from 8.21 to 10.42 p.m. Our illustration is an exact copy of the photograph, and it will be seen the band of light is perceptibly diminished in size as the moon became more and more eclipsed.

Copy of Photograph by Moonlight, showing the path of the Moon during its partial eclipse. Time of exposure, 2 hours 20 minutes.

## EVENING TECHNICAL INSTRUCTION IN ENGLAND.—II. *

NO payment is made unless the student has received at least twenty lessons during the session from his teacher, and for the satisfaction of the Department, registers of attendance of each school are sent to the Central Office.

To the students who pass the examination, certificates and prizes are given, and to those who take the highest places, bursaries, which enable them to pursue their studies in the Normal School in London, are awarded.

II.—Schools for the teaching of industrial art are organised on almost the same principles as those of science. Subventions are made from the Central Department towards the erection of these schools, and towards the purchase of books, models, engravings, photographs, etc. Every year there is an examination in London of all the pupils' works in the different schools throughout the country, and the subventions to the several schools depend upon the number and excellence of the works executed by the pupils. The subjects of instruction in the art schools for which payments are made are grouped under the following heads :—

(*a*) Drawing, including Freehand, Geometry, and Perspective.
(*b*) Architecture.
(*c*) The Principles of Ornament and Composition.
(*d*) Painting.
(*e*) The study of Figure, including Anatomy, Drawing, and Painting from the Living Figure, and Painting from the Antique, Composition.
(*f*) Modelling.

The number of students in the several art classes throughout the kingdom was 61,151 in the year 1885, and 69,837 in the year 1886. The number of separate works sent to South Kensington in 1885 was 612,446, and in 1886, 722,519. These figures do not include the number of works marked by the examiners at the schools themselves. To the successful pupils certificates, money prizes, and medals are awarded as in the science schools, and those who take the highest places in the examinations receive bursaries, which enable them to continue their studies in the Normal School of Decorative Art at South Kensington.

In the year 1884, there were 188 schools of art, with 37,033 students in attendance, and the subvention of the Department, on the results of the examination of these students, was £21,528. Besides these schools of art, there were 490 separate courses of instruction, attended by 23,745 students, for the instruction of whom the subvention of the Department amounted to £7,712. In addition to the aid given by the Department towards the instruction of students in art schools, subventions are made to defray the cost of the instruction in drawing of children in elementary schools. Until now, drawing has not been made an obligatory subject in the elementary schools of England, and the Department at South Kensington has encouraged instruction in drawing in elementary schools by making "payments on results." In the year 1884, 778,830 pupils received instruction in drawing, for which the Department made a grant of £33,129. The total amount of the Department's subvention towards art in the year 1884 was £66,652.

* Translation of a paper by Sir Philip Magnus, read before the Industrial Section of the Technical Education Congress held at Bordeaux.

For some years after these art schools were first established, the complaint was made that the instruction in drawing was too general, that it was not specialised according to the requirements of the trade of the district. It was said, that the student learnt to draw and paint mediocre pictures for the *salon* instead of useful designs for manufacturers, and that the designs they made were not adapted, owing to the student's ignorance of the *technique* of the trade, to the machinery employed to produce them. For some time this was the case, particularly in the designs for *cretonnes* and other cotton goods. But now a great improvement has taken place in our industrial art teaching. The artist understands the conditions of the industry for which he designs, and I am glad to say that we are no longer dependent to the same extent as we were on the artists of Paris for our trade designs. In the manufacture of lace, carpets, wall-papers, hangings, and furniture, English designers are almost exclusively employed.

In connection with the facilities for instruction in art offered by the Department, mention must be made of the fact that the authorities of the South Kensington Museum have organised a system for circulating objects of art and books suitable for exhibition in local museums and art schools. All workmen who are students of the local schools are admitted gratuitously to these museums, and in order that the workmen who are employed in the daytime may partake of the benefits to be derived from the collection, the charge on two evenings a week must not exceed one penny for each person.

The influence of industrial museums on technical instruction is gradually being more appreciated in England, mainly through the action of the Department of Science and Art. Manufacturers, however, do not yet seem to fully recognise the real value of such collections. They show very little interest in the development of these museums, and are not so willing to co-operate in improving and adding to the collections as are the manufacturers of France and Germany. In many museums both in France and Germany, I have seen collections of all the newest patterns, contributed by the manufacturers themselves, which are open to the inspection of the general public. There can be no doubt that in this way each manufacturer benefits by the work of others, and the general industry of the town is advanced by the knowledge gained by workmen and their employers of all that has reference to the trade in which they are engaged. Efforts are being made to induce English manufacturers to assist in the formation of local museums, but from the reserved character of the English people, and from the false notion of manufacturers that it is possible to preserve "trade secrets," English workmen have not sufficient opportunities of examining the newest patterns and the newest processes of manufacture.

Attached to the South Kensington Museum there is an art library, with a collection of nearly 60,000 volumes, of more than 24,000 drawings, and 69,000 photographs.

III.—I have now to speak of the encouragement given to instruction in the technology of different trades, as distinguished from instruction in the elements of pure and applied science. From what I have already said, it will be seen that the schools for instruction in science are supported in part by the inhabitants of the towns in which they are situated, and in part by the subventions of the State; but this instruction is not specialised in its application to the particular trades. In fact, it is general rather than technical or industrial, and is intended to be so. Now the number of trades is so numerous, that the question of providing specific instruction adapted to the requirements of persons engaged in each particular industry, is full of difficulties; and considering that the teaching of science and of art constitutes the basis, and, indeed, the greater part of all technical education, the Department of the Government in restricting its operations to the encouragement of this kind of teaching, has done nearly all that can be expected of the State. The great difficulty in teaching science to workmen in evening classes, is that the workman has very little time to devote to the study, and is naturally desirous of considering those problems which have reference to the particular branch of industry in which he is engaged. Such students are not attracted to the study of science pure and simple, but are desirous of seeing the connection between the problems of the workshop and the principles of science as taught in the school. Supplementary instruction of this kind, connecting the teaching of pure science with workshop practice, workmen are now able to obtain in the courses of instruction organised by the City and Guilds of London Institute.

This Institute was established in the year 1879. It consists of an Association of some of the Ancient Trade Corporations of London. These Corporations or Guilds are possessed of very large properties, owing to the rise in the value of the land which centuries ago was bequeathed to them. Established for the protection of their own trades, they have, to some extent, outgrown the purposes for which they were originally founded. A few years since many of them united and formed an Association in conjunction with the City of London in order to promote technical education. In the year 1880 they were incorporated as the City and Guilds of London Institute, and since then they have established in London a school for engineers and manufacturers (similar in some respects to the Ecole Centrale of Paris, and to the Polytechnic Schools of Germany), which has been built at a cost of £100,000, and is supported by a subvention from the Guilds of £10,000 per annum. They have also established a technical school for the training of foremen, and for the education of boys who leave school at about the age of fifteen, and in this school, known as the "Finsbury Technical College," evening classes in several branches of technology have been established, which are attended by about 700 students. In the south of London the Institute has founded a school of art, in which instruction is given in painting on porcelain, in wood engraving, in sculpture, and in drawing and modelling, in their application to other industries. Besides establishing these schools in London itself, the Institute affords encouragement to the formation, throughout the country, of evening classes in the technology of various trades. The Institute has adopted from the Science and Art Department the principle of "payment on results." The organisation of these classes in technology is in all respects similar to those in science. The courses of technology under the direction of the Institute are held in the same schools as the courses of science under the direction of the State, and in most of these schools the student is encouraged to learn the elements of science for two years, and afterwards to study the technology of the particular trade in which he is engaged.

(*To be continued.*)

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Areas of Circles.—The following is a very simple method of finding the diameter of a circle or pipe, whose area shall be equal to that of any other two circles or pipes of known dimensions. No calculation is required, as the whole can be done in the simplest way by measurement on a board. Take a piece of board which has two edges at right angles to one another, or take a carpenter's square, and on one edge mark the diameter of one of the circles or pipe, and on the other edge (at right angles to it) the diameter of the second circle or pipe. Draw a line diagonally from the mark on one edge of the board to the mark on the other edge, and the length of this diagonal will be the diameter of a third pipe or circle which shall have an area equal to the areas of the two pipes or circles whose diameters were marked on the board.

## COLOURED GLASS IN THE UNITED STATES.

UNTIL quite recently but little coloured glass, with the exception of common black and amber bottles, was made in the United States. Now quite a number of glass-works are engaged in its manufacture exclusively, and at others it forms a large part of the product. The colouring materials most largely employed are iron, manganese, copper, cobalt, and gold. These are generally used as oxides, though in some cases, but very rarely, other compounds are used. In addition to the above, arsenic, uranium, chromium, and silver are occasionally employed. As was pointed out by Bontemps many years ago, the colouring properties of the metallic oxides are greatly modified by the degree of heat to which the glass is subjected, and by other circumstances. Not only will different temperatures give different shades of the same colour, but even different colours. Manganese, for example, which is the great decolourizer of glass, so universally used for the purpose as to be known as "glassmaker's soap," is used as a colourer, chiefly to impart a pink or purple to glass. If, however, the glass so coloured remains too long in the furnace, it becomes pale or reddish brown, then yellow, and finally green. From the oxides of iron all the colours of the spectrum may be produced, and in the order in which they appear in the spectrum. Its primary effect upon glass is to give it a green tinge. Hence in the manufacture of white glass sand containing much iron is carefully avoided; what little it does contain—and there is always more or less present—is neutralised by the oxide of manganese. Oxide of iron, however, produces other colours than green. Indeed, the green of this oxide has but little brilliancy, and when rich emeralds are desired other materials are used, such as oxide of copper. Iron will produce in enamels, which are only glasses, a fine purplish red, or, under a stronger heat, an orange. If a piece of iron is thrown into the pot of a flint-glass house, during the blowing, the glass in its neighbourhood will be orange or yellow. In window-glass houses, the addition of a small proportion of oxide of iron gives a bluish tint to the glass, while it is well known that the glass left in the pots of the bottle-houses becomes an opaque blue. Oxide of copper is chiefly used to produce reds, rubies, and purples in the cheaper kinds of glass. To produce these reds with copper, however, requires skilful manipulation, as they are not all fixed. The temperature must be kept at the lowest possible point, otherwise the glass changes to a purple, then to a sky blue, with a tendency to green. A heat between the minimum which gives a blue and the maximum which gives a red, produces a purple. The finest rubies, reds, purples, violets, etc., are produced by gold. The purple of Cassius (which is a mixture of the oxides of gold and tin), or some similar preparation of gold is used. The colouring power of gold is so great that one part of gold will give a full, rich body of colour to from 600 to 1,000 parts of glass. The glass coloured with gold can be made to assume a scarlet, carmine, rose, and ruby. Cobalt gives a blue which is unalterable in any fire. It is also used for some of the finer blacks. Carbon, usually as powdered cannel coal, is the colouring matter chiefly used in the manufacture of black and amber bottles. Plumbago was at one time largely used, and is still to some extent.—*Mineral Resources of United States.*

## THE ROYAL INSTITUTION.

### The Element of Truth in Popular Beliefs.

THIS formed the subject of a weekly evening lecture by Dr. Lauder Brunton:—

The common saying, "Seeing is believing," gives a clue to the origin of many popular delusions, for the evidence of our eyes is by no means to be trusted, and unless corrected by the observations derived from other senses, will often prove deceptive. Some popular beliefs are correct in regard to fact, but erroneous in regard to interpretation. Some others, which in their present form are absurd, are the survivals, or modifications, of other beliefs which were true.

In endeavouring to discover the element of truth in any belief, we may be aided by tracing its history backwards in time, or by comparing it with allied forms of belief in different places.

As an example of the historical method, we may take the belief that horse-flesh is unfit for food, a delusion which arose from the circumstance that horse-flesh was unfit for Christian food, inasmuch as the horse was sacred to Odin, and eating its flesh was a sign of Paganism.

As an illustration of the comparative method, we may take the belief that a person cannot die if any door in the house be locked. Other forms of the belief are that a person cannot die as long as the doors or windows of the room in which he is lying are closed, and observation enables us to ascertain that this is due to the fact that the room is thus kept warm, and life therefore prolonged.

The belief that disease may be cured by hanging up rags in a sacred place may be connected, by intermediate forms, with the fact that infectious diseases may be conveyed from one to another by articles of clothing.

Some omens probably have an historical origin. Others depend on physical conditions, such as stumbling on leaving the threshold as an indication of coming misfortune. This may be regarded as simply an evidence of a deficiency in the motor power of the individual which may cause him to fail in an emergency.

Others, again, may be referred to indistinct sensations or sub-conscious conditions. Dreams are frequently influenced by the circumstances of the dreamer, either at the time or some days before, and hallucinations, as well as visions of ghosts and fairies, may be regarded as forms of waking dreams.

The signs which were regarded in the Middle Ages as distinctive of witchcraft, are now looked upon as symptoms of hysteria, and the condition of hysteria may perhaps be defined to be one in which impressions, originating within the body itself, tend to overpower those transmitted from without by the usual sensory channels.

The phenomena of thought-reading and of the divining rod may in many cases be explained by the fact that sensory impressions may be received, and may lead to action, without rising into complete consciousness in the individual who receives them.

### Etiology of Scarlet Fever.

PROFESSOR EDWARD E. KLEIN, F.R.S., gave an evening lecture on the above subject. He said that among the infectious or zymotic diseases there are two, at any rate, —namely, scarlet fever and diphtheria—of which it may be said that their spread is, to a lesser extent, dependent on defective domestic sanitation than is the case with some of the other zymotic diseases, as, for instance, typhoid fever. Indeed, it is maintained by competent authorities that scarlet fever and diphtheria do not invade houses of faulty sanitation with greater frequency or severity than those of perfect sanitary arrangements. This view is based on the important experience gained during the past twenty years—viz., that epidemics of scarlet fever and diphtheria have been brought about by milk. He then stated, by way of explanation, that a fact well established and needing no further comment is that scarlet fever and diphtheria are, like small-pox, measles, whooping cough, and typhus fever, communicable directly from person to person. This mode of infection, doubtless an important one, and coming into operation in single cases wherever the elementary rules of isolation and disinfection are transgressed, altogether sinks into insignificance when compared with the infection produced on a large scale, if a common article of diet like milk should become in some way or another the vehicle of contagium, as has been proved to be the case in a number of epidemic outbreaks. These epidemics, known as milk scarlatina, milk diphtheria, and, he might also add, milk typhoid, have this in common, that almost simultaneously, or, at any rate, within a short time, in a number of houses having no direct communication, by person or otherwise, with one another, there occur, sometimes singly, sometimes in batches, as it were, cases of illness—scarlet fever, diphtheria, or typhoid fever, as the case may be; and it was this peculiar character which pointed to a condition which must have been common to all these households. On closer examination it was, indeed, found that all these households had this, and only this, in common, that they were all supplied with milk coming from the same source—that is to say, from the same dairyman. Other houses, supplied with milk from a different source, escaped; and, further, it was shown that, as soon as the consumption of the suspected milk ceased, the epidemic, as such, came to an end, except, of course, the cases due to secondary infection from person to person.

The Medical Department of the Local Government Board have had for years past their attention fixed on these milk epidemics, and in the reports of the medical officer many of these are described with great detail; amongst these Dr. Ballard's report in 1870 on Enteric Fever in Islington, Dr. Buchanan's on Scarlet Fever in South Kensington in 1875, and Mr. Power's on Scarlet Fever in St. Giles's and St. Pancras in 1882, are especially to be referred to. Mr. Ernest Hart has tabulated all the outbreaks of milk epidemics which were investigated before 1881 in vol. iv. of the "Transactions of the International Medical Congress for 1881." Now, analysing these outbreaks as far as they refer to scarlet fever, there are several of them where the assumption that the milk consumed acquired the power of infection by contamination from a human source cannot be excluded. This infection, if proven, would stand on the same footing as if due to contagion from person to person; for it is clear, whether the contagium is conveyed from one person to another by air, food, drink, or otherwise, it always remains contagion from person to person. Now, in many of the cases of epidemics tabulated by Mr. Hart, and recorded by subsequent observers—*i.e.*, after 1881—this mode of milk contamination cannot be excluded, as I said before; but comparing the dates when the milk was supposed to have become so contaminated with the dates when the milk has actually produced infection, it will be found that a certain discrepancy exists, and, as will be shown later, another mode of infection—viz., from a person affected with scarlatina to the cow, and through the cow to the milk, and then to human beings—cannot be excluded either. There are other epidemics recorded in these tables in which the mode of infection of the milk is not ascertained, and in a third set the milk acquired infective power in some way or another, but certainly not from a human source.

Examples of each kind were given, and the lecturer stated that the Medical Department of the Local Government Board have from these facts drawn the conclusion that "distrust must be placed on the universally accepted explanation that milk receives infective properties directly by human agencies," and further that "the question of risk from specific fouling of milk by particular cows suffering, whether recognised or not, from specific disease was seen to be arising." This view received striking confirmation and proof by a report of an outbreak of scarlet fever that occurred at the end of 1885 and the beginning of 1886 in the north of London, which was investigated by Mr. Power. This report is published *in extenso* in the Report of the medical officer of the Local Government Board for 1886, and in this it was shown that at this Hendon farm there existed certain cows affected with a communicable disease which, in many points of its pathology, bears a great resemblance to human scarlatina; further, that the milk of these cows gave scarlet fever to human beings; and, lastly, that a particular microbe was obtained from these cows, which in calves produced a similar disease to the disease of those cows.

In order to complete the evidence thus far obtained, it was necessary to prove that scarlet fever in man is due to the presence and multiplication in the blood and tissues of the same micrococcus, and that this microbe, if obtained from human scarlet fever, produces in the cow the same disease as is produced by the micrococcus of the Hendon cows. Now, this proof has been satisfactorily given. In the first place, it has been shown that in the blood and tissues of persons affected with scarlet fever there occurs the same micrococcus as was present in the cow, both being identical in microscopical and in cultural characters. In the second place, it was found that the action of this microbe on animals is exactly the same as the micrococcus found in the Hendon cows. Calves and mice after inoculation or feeding with a trace of the growth of both sets of micrococci, become affected with cutaneous and visceral disease similar to human scarlet fever; in calves the disease is of the same mild type as in the Hendon cows. Further, it was shown that from the blood and the tissues of these animals infected with one or the other set of cultivations the same micrococcus was recovered. This microbe, *micrococcus scarlatinæ*, is the cause of human scarlet fever; further, it produces in bovine animals a disease identical with the Hendon disease and human scarlet fever, and consequently, while the cow is susceptible to infection with human scarlet fever, it can, in its turn, be the source of contagium for the human species, as was no doubt the case in the milk epidemic from the Hendon farm.

The lecturer then came to the question—How is the spread of scarlet fever by milk to be controlled and checked? This question, he said, resolves itself into three parts. First, prevention of infection of the cow by man, directly or indirectly; second, prevention of infection of the cow by the cow; and, third, destruction of the contagium of the milk of such cows. As regards the first, all those rules which have been laid down to prevent infection of one human being from another, of milk or any dairy utensil, by contact or otherwise, with a person suffering from scarlet fever or coming from an infected house, also apply here; and this part of the subject comes under the general aspect of the proper sanitary management of dairies which is acted upon in all well-managed dairies. As regards the second, this is obviously more important and more difficult of carrying out. The disease in the cow, being of a mild character, is easily overlooked. The disease in the skin of the cow may be present and slight, or may be absent in its more conspicuous manifestation, whereas the visceral disease is of so mild a character that it requires an expert to diagnose it. The third question, as to the destruction of the contagium in the milk, he was glad to say, is very easily carried out. He had found that heating milk up to 85° C., or 185° Fah.—that is, considerably under the boiling point—is perfectly sufficient to completely destroy the vitality of the microbe of scarlet fever.

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## PHYSICAL SOCIETY OF BERLIN.

At a recent meeting, held under the presidency of Prof. Du Bois-Reymond, Dr. Sommer spoke of the methods for determining the specific weight of bodies, with special reference to the method by weighing them in water. After having discussed the earlier methods and experiments of Marck and Lépiney, he gave an account of the methods he had himself employed in order to do away with the influence which the capillary forces at the surface of the water exert on the wire by which the solid is suspended. He surrounds the wire at the point where it enters the water with a glass tube 5 mm. in width, in which is placed one drop of a mixture of equal parts of olive-oil and benzene. From the lower end of the wire in the distilled water he hangs a tiny tray on which two cubes of quartz are placed. Using a wire 0·1 mm. in diameter, which he finds gives a result as accurate as weighing in air, he determines the weight of these quartz cubes in water, then pushes one of the cubes off the tray by means of a platinum wire which had been previously submerged, and weighs again. He then pushes the second cube off the tray and weighs a third time. These three weighings, taken in conjunction with the weight of the tray and cubes in air, yield an exactitude which up to the present time has either not been attained at all by hydrostatic methods or only by a laborious and roundabout process. The exactness of this method of determining the specific weight of quartz cubes surpasses that obtained by the use of a piknometer. The President gave an account of a communication which had been made by Siemens at the last meeting of the Akademie der Wissenschaft. A steel tube 10 cm. long, with perfectly smooth external and internal surfaces and extremely uniform bore, and whose walls are apparently of perfectly equal thickness at all points, was prepared by the following method, patented by Männermann in Bemscheid. Two rollers, slightly conical towards their lower ends, are made to rotate in the same direction near each other; a red-hot cylinder of steel is then brought between these cylinders, and is at once seized by the rotating cones and is driven upwards. But the mass of steel does not emerge at the top as a solid, but in the form of the hollow steel tube which Siemens laid before the meeting. Prof. Neesen gave the following explanation of this striking result: owing to the properties of the glowing steel, the rotating rollers seize upon only the outer layer of the steel cylinder and force this upwards, while at the same time the central parts of the cylinder remain behind. The result is thus exactly the same as is observed in the process of making glass tubes out of glass rods.

## THE GEOLOGICAL SOCIETY.

AT a meeting held on June 23rd, Professor J. W. Judd, F.R.S., president, in the chair, the following communications were read:

1. "On Nepheline Rocks in Brazil, with special Reference to the Association of Phonolite and Foyaite." By Orville A. Derby, Esq., F.G.S.

The author referred to the phonolites and associated basalts of Fernando Noronha, a deep-sea island off the north-eastern shoulder of the continent of South America. Nepheline rocks of a somewhat different character are abundantly developed on the mainland, and under conditions favourable for throwing light on the relations existing between the granite type, foyaite, and the other members of the group. There are some mountains near Rio de Janeiro composed of these rocks, as is also the peak of Itatiaia, 3,000 metres high, the loftiest mountain of eastern South America. A cursory examination of some of these localities having shown an apparent relation between foyaite, phonolite, trachyte, and certain types of basalt, Mr. Derby determined to visit the Caldas region, where a railway under construction gave unusual facilities for examining this series. A fine development of foyaite, phonolite, and tuff was found, associated with several types that have not yet been met with in the other localities. The existence of a leucite basalt was recognised.

The bulk of the paper was devoted to a detailed description of these railway-sections, and the following deductions are drawn:—(1) The substantial identity, as regards mode of occurrence and geological age, of the Caldas phonolites and foyaites. (2) The connection of the latter through the phonolites with a typical volcanic series containing both deep-seated and aërial types of deposits. (3) The equal, if not greater antiquity of the leucite rocks as compared with the nepheline rocks, whether felsitic, as phonolite, or granite as foyaite. (4) The probable palæozoic age of the whole eruptive series.

In the discussion which followed the President remarked that it was seldom that a paper containing such important facts was presented to the Society. It was reserved to Mr. Derby to have proved that plutonic rocks containing nepheline (foyaite) passed into volcanic masses which were true phonolites. This Mr. Derby had clearly established by observations in the field. He had also shown that leucite existed in rocks of palæozoic age, thus rendering untenable the last stronghold of those who insisted on making geological age a primary factor in petrographical classification. He alluded also to the value of the independent determinations of Professor Rosenbusch.

2. "Notes on the Metamorphic Rocks of South Devon." By Miss Catherine A. Raisin, B.Sc. Communicated by Professor T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S.

This communication consisted mainly of detailed observations, supplementary to those published by Professor Bonney in the Society's Journal for 1884, on the slaty and metamorphic rocks of South Devon in the neighbourhood of Salcombe estuary. In the first part of the paper, details were given of the sections exposed around the estuary, at Hope Cave to the westward, and in several localities to the eastward as far as Hall Sands, all confirmative of Professor Bonney's views, and showing that the slaty beds to the northward do not pass into the mica and chlorite schists to the south, but are separated from the latter by a line of faults. Descriptions were then given of microscopic slides from various parts of the metamorphic rocks. Some of these showed the action of secondary forces. The effects of lateral pressure in producing cleavage-planes and a kind of jointing were also commented upon.

3. "On the Ancient Beach and Boulders near Braunton and Croyde in North Devon." By Professor T. M'Kenny Hughes, M.A., F.G.S.

The author observed that amongst the raised beaches of S.W. England, we generally find included the sand cliffs of Saunton Down and Middleborough on the coast west of Barnstaple. These deposits possess a further interest owing to the occurrence at their base of large boulders. In 1866 Mr. Spence Bate, in opposition to the prevailing views, concluded that the so-called raised beach is the undestroyed remnant of an extensive district of wind-borne sand similar to that which now exists on Braunton Burrows. The points to which attention was invited are as follows:—

(1) Is this deposit on the southern slope of Saunton Down a raised beach?

(2) Were the above-mentioned boulders carried to their present position by ice?

The paper was fully illustrated by diagrams, showing the relations of the recent deposit, and by figures showing the mode of occurrence of three of the most remarkable boulders. The conclusions were:—

(1) That the ancient beach of Saunton Down and Croyde is not a *raised beach* in the ordinary acceptation of the term. The top is subaërial talus, the middle part is blown sand, the base only marine, and the marine part is not above the reach of the waves of the sea at its present level. (2) The boulders of granite and felsite which occur at the base of the ancient beach were transported to their present position by the waves of the sea. Such as are of local origin could have reached the sea by the ordinary processes of denudation; such as are possibly of northern origin could have been carried down the Irish Channel on bergs, and been thrown up by the sea to their present position at any period subsequent to their transportation southwards by ice; but their presence does not imply any *local* glaciation.

4. "Notes on the Formation of Coal-seams, as suggested by evidence collected chiefly in the Leicestershire and South Derbyshire Coal-field." By W. S. Gresley, Esq., F.G.S.

The author's principal object in this paper was to bring forward evidence in opposition to the view now generally accepted that coal-seams were formed from vegetation growing on the spot.

He showed that during a very extensive experience he had only once or twice detected stems passing into a bed of coal and connected with the Stigmaria-roots in the underclay. If, as was generally stated, the Stigmariæ were the roots of the trees that formed the coal, such instances ought to be common. Not only, however, were they very rare, but the abundance of the Stigmariæ was extremely variable, and these roots, instead of becoming more thickly matted together in the uppermost part of the underclay, as they should be if they were roots of the coal-forests, were generally distributed, as a rule, throughout the clay in a manner that showed them to have been, in all probability independent organisms. Stigmarian roots, when found connected with a stem, were more often on the top of the coal-seam than at the bottom.

## REVIEWS OF BOOKS.

*Progress.* By James Platt. London: Simpkin, Marshall, and Co.

Time was when the bulk of mankind believed that the world was gradually and continuously getting worse. A golden age of peace, plenty, and content, had been, so they believed, succeeded by an age of silver (a little inferior), and that, again, in turn by a brazen and an iron age. In the earlier portion of the modern ages there set in a change of opinion. The doctrine of "progress" was preached; we were told that the world, and especially mankind, was constantly and in all respects improving. And when the theory of organic evolution was established by the labours of Darwin and his coadjutors, it was rather hastily concluded that the idea of progress had received its full scientific consecration.

From the title of this book we were led to expect an examination of the causes, the principles, and the limits, of progress. We hoped that the author would have shown that mankind does not move along one uniform track, but that it is capable of turning to the right or to the left in endless manners and matters; capable, too, of advancing in some particulars whilst remaining stationary or retrograding in others. We expected, further, that he would have explained when, where, and how, the tendency to change ought to be resisted, and when this attempt may prove successful. For such a work there is, we should think, not merely room, but most pressing occasion.

Mr. Platt's undertaking is of a quite different character, as it will appear from the headings of its chapters—Causality, Acquisitiveness, Capital, Free Labour, *Employés*, Technical Education, Production, Distribution, and Progress.

He is essentially an economist of the Adam Smith type, and hence he takes too narrow a view of the world. He is a phrenologist, admiring George Combe and the "Constitution of Man." He accepts the doctrine of evolution, especially as far as the "survival of the fittest" is concerned. But it may be questioned whether he keeps steadily in view how the fittest to survive in an impure atmosphere are the vilest. He preaches the gospel of success, contending that if either man or book fails to command appreciation, the fault lies in him or in it, and not in the times, in circumstances or surroundings. Evidently he does not believe that pearls ever are or can be thrown before the swine. But what if we apply his test to phrenology?

We are pleased to see the author recognise the deadly effects of Puritanism on the arts and art-industries. The glass-stainers were swept away by the Puritan revolution, as well as the sculptors, painters, and musicians. Mr. Platt might have added that literature, science, and philosophy, have suffered, and are still suffering from the same cause. If we are inferior to some of our neighbours in designing, the blame rests with "Praise God Barebones" and his like. Though we find in this volume much which we cannot fully accept, we still regard it as one which may be profitably studied.

## BOOKS RECEIVED.

"Metal Plate Work." By C. T. Millis. London: E. and F. N. Spon.

A systematic and thoroughly practical guide for workers in this subject, with good illustrations. Forms one of the Finsbury Technical Manuals.

"Proceedings of the Royal Society of Edinburgh—Session 1885-86."

Valuable papers covering a wide range of subjects.

"The Journal of Microscopy and Natural Science; the Journal of the Postal Microscopical Society," July 1887. London: Baillière, Tindall and Cox.

Papers on Dimorphism in Fungi; Eyes of Molluscs and Arthropods, etc.

"Transactions of the Mining Association and Institute of Cornwall" (Camborne), 1887.

Chiefly of local interest.

"The Journal of the Society of Chemical Industry," June, 1887.

Technical articles and descriptions of new patents.

"Minutes of Proceedings of the Institution of Civil Engineers." With other selected and abstracted papers. Vol. lxxxix.

Several of the papers are of general interest, such, for instance, as those on Printing Machinery, Salmon Ladders, Gas-power *v.* Steam-power. As usual, the editing and illustrations are excellent.

"Journal of the Society of Telegraph Engineers and Electricians." No. 67. Vol. xvi. London: E. and F. N. Spon.

Chiefly technical, but papers on Underground Telegraphs and Driving of Dynamos with Short Belts are of general interest.

"The Scientific Proceedings of the Royal Dublin Society." Vol. v. (N. S.) Vol. iii. (Series II.)

Include many valuable papers on various subjects. Several on geology; one on the Fossil Fishes of the Chalk of Mount Lebanon, in Syria, being admirably illustrated.

"The Moloch of Paraffin." By Charles Marvin. London: R. Anderson and Co.

Deals chiefly with the dangers attending the use of nearly every description of paraffin lamp.

## SCIENTIFIC MEETINGS AND EXHIBITIONS.

International Congress of Geologists.—In view of the meeting of the International Congress of Geologists, to be held in London next year, the Nomenclature Committee of the Congress will assemble at Manchester during the forthcoming meeting of the British Association. A scheme has recently been put forward for the purpose of securing uniformity on questions of nomenclature and classification.

Brussels International Exhibition.—An International Exhibition of Science and Industry will be held at Brussels next year from May to October, when premiums will be awarded to the amount of £20,000, and articles to the value of £40,000 will be bought for prizes in the lottery authorised by the Belgian Government. The Commissioner's office is at 11, Place de Louvain, Bruxelles.

Geneva Horological School.—The silver medal offered to the students of the Geneva Horological School for excellence of work has been won by Walter Vokes, son of Mr. E. J. Vokes, of Bath, who is a member of the British Horological Institute.

Paris Brewing Exhibition.—The leading brewers in France are preparing an exhibition of beer and of the products and apparatus used in brewing, which is to be held in Paris this autumn. The brewing trade has of late years increased very much in importance, as, owing to the inroads of the phylloxera and the mildew, the consumption of wine has to some extent been replaced by that of beer. The French brewers hope that this exhibition may lead to the institution of a school of brewery similar to those existing in Germany and Austria.

New York Electrical Exhibition.—Under the auspices of the New York Electrical Society, an Electrical Exhibition will be held in New York from 28th September to 3rd December of this year, and as no electrical exhibition has previously been held in that city, it is expected that it will attract much attention.

The Iron and Steel Institute.—The annual autumn meeting of the Iron and Steel Institute will this year be held in the Owens College, Manchester, commencing on Wednesday, 14th September. An influential local committee has been formed for the reception and entertainment of the Institute, and the following papers on interesting subjects have been promised: Testing Machines; Recent Metallurgical and Mechanical Progress; The Basic Open Hearth Process; Apparatus for Continuous Moulding; Electric Light Installations for Factories; and the Manufacture of Ordnance at the Royal Arsenal of Trubia.

Geneva Society of Arts.—This society offers prizes for the best treatises on watch mainsprings. The competition is international, except that Swiss residents alone can obtain money prizes in addition to the silver and bronze medals and diplomas, which will be awarded without regard to nationality. Papers, drawings, and models are to be delivered at Geneva before the 30th November next.

Berlin Physical and Technical Institute.—This Institute is being formed, not for teaching but to facilitate research, the curators being always accessible, as experts, to assist investigators. Professor Helmholtz has been appointed President, and the Institute is to be opened in April of next year.

Chronometer Tests at the Greenwich Observatory.—We learn from the *Horological Journal* that Mr. Uhrig has followed up his success at the last annual trial by again taking the premier position. Mr. Mercer comes second, and Messrs. C. Frodsham and Co. third. Messrs. Johnson and Son, of Derby, who take the fourth and fifth places, are said to be new competitors. The first six instruments were purchased by the Admiralty.

The Whitworth Scholarship.—The chief Whitworth Scholarship of £200 has this year been gained by Mr. James Whitaker, engineer student, Burnley. Among the others a scholarship of £150 has been gained by Mr. R. N. Blackburn, engineer apprentice, Liverpool; one of £100 by Mr. B. G. Oxford, engineer apprentice, Liverpool; and one of £100 by Mr. B. H. Crookes, engineer student, Liverpool.

Motors for Electric Lighting.—The Council of the Society of Arts are prepared to award four gold medals and four silver medals for prime motors suitable for electric light installations. The medals will be awarded on the results of practical tests. The competition will take place in London about May or June, 1888, and entries must be sent in by the 31st December, 1887.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

9725.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Dynamo-electric machines." 12th July, 1887.

9726.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Armatures for electric generators." (Complete Specification.) 12th July, 1887.

9727.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Commutators for electric machines." (Complete specification.) 12th July, 1887.

9728.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electric converters and boxes for same." (Complete specification.) 12th July, 1887.

9729.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electric converters." (Complete specification) 12th July, 1887.

9730.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Voltmeters." (Complete specification.) 12th July, 1887.

9731.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Ammeters." (Complete specification.) 12th July, 1887.

9732.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electrical indicators." (Complete specification.) 12th July, 1887.

9733.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electric circuits and apparatus therefor." (Complete specification.) 12th July, 1887.

9734.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Transmission of electricity from sources distant from where they are to be utilised." (Complete specification.) 12th July, 1887.

9735.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electrical distribution." (Complete specification.) 12th July, 1887.

9736.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Connecting alternate current electric generators and apparatus therefor." (Complete specification.) 12th July, 1887.

9737.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electrical distribution and conversion." (Complete specification.) 12th July, 1887.

9738.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electrical distribution and conversion." (Complete specification.) 12th July, 1887.

9739.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electric circuits and automatic controlling apparatus therefor." (Complete specification.) 12th July, 1887.

9740.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electrical distribution." (Complete specification.) 12th July, 1887.

9741.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electrical distribution or apparatus for supplying or distributing electricity to electric railways, incandescent lamps, or other like purposes." (Complete specification.) 12th July, 1887.

9742.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Circuit controlling apparatus for electric circuits." (Complete specification.) 12th July, 1887.

9743.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Incandescent electric lamp sockets." (Complete specification.) 12th July, 1887.

9744.—WILLIAM PHILLIPS THOMPSON, 6, Lord Street, Liverpool. A communication from George Westinghouse, junior, United States. "Electric conductors or cables." (Complete specification.) 12th July, 1887.

9800.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Reuben Clarke and William Ferguson Munro, Canada. "Window fasteners." (Complete specification.) 12th July, 1887.

9801.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Johanna Martha Fischer, Dresden. "Apparatus for signalling a predetermined degree of heat." (Complete specification.) 12th July, 1887.

9802.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Bernhard Gruhl, Dresden. "Apparatus for cutting cartridge cases, drawn tubes or pipes, and the like." (Complete specification.) 12th July, 1887.

9803.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from John Wesley Blodgett, United States. "Button hole attachments for sewing machines." 12th July, 1887.

9804.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Fernando Cuervas-Mons. "Protecting the hulls of vessels." 12th July, 1887.

9979.—ROOKES EVELYN BELL CROMPTON, Chelmsford, and JOHN C. HOWELL, Llanelly. "Circulation of electrolyte in electric depositing vats, accumulators, etc." 16th July, 1887.

10183.—WILLIAM CLARKE, JOHN BROKENSHIRE FURNEAUX, and CHARLES DOWSEN, 46, Lincoln's Inn Fields, London. "Steam-engines." 20th July, 1887.

10184.—WILLIAM CLARKE, JOHN BROKENSHIRE FURNEAUX, and CHARLES DOWSEN, 46, Lincoln's Inn Fields, London. "Steam pumps" 20th July, 1887.

10189.—ROBERT BENTHAM, 66, Lord Street, Hindsford, Atherton, Lancashire. "Miners' portable electric lamps." 21st July, 1887.

10217.—JAMES SERSON and JAMES ORVILLE WHITTEN, 45, Southampton Buildings, London "Galvanic batteries." (Complete specification.) 21st July, 1887.

10256.—GEORGE LOWRY and ROBERT WILBY, Barnsley. "Steam boilers and similar vessels." 22nd July, 1887.

10287.—FREDERICK KING and WILLIAM PHILLIPS MENDHAM, Narrow Wine Street, Bristol. "Electric Telephones." 23rd July, 1887.

10350.—MAX GEHRE, 323, High Holborn, London. "Regulating the superheating of steam." 25th July, 1887.

10395.—JOHN KING MACDONALD, 62, St. Vincent Street, Glasgow. A communication from Singer Manufacturing Co., United States. "Shuttles and shuttle carriers for sewing machines." 26th July, 1887.

10514.—VICTOR JUSTIN JEAN HIRBEC, 4, South Street, London. "Apparatus for storing electricity and facilitating the utilisation thereof." 28th July, 1887.

10555.—CHAIMSONOVITZ PROSPER ELIESON, 4, South Street, Finsbury, London. "Electrical batteries." 29th July, 1887.

10611.—RICHARD PHILIP MILBURN, 46, Grainger Street West, Newcastle-upon-Tyne. "Electrical batteries." 2nd August, 1887.

10621.—JOHN DICKSON, of the firm of John Dickson and Son, 12, Rothesay Place, Edinburgh. "Breech-loading fire arms." 2nd August, 1887.

10663.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from James F. McLaughlin, United States. "Electrical type-writers." (Complete specification.) 2nd August, 1887.

10716.—THOMAS MORRIS KNIGHT, 55 and 56, Chancery Lane, London. "Electric coverings for indicating abnormal conditions." (Complete specification.) 4th August, 1887.

10754.—JOHN HARWOOD SIMPSON and SAMUEL PORTER, 4, Clayton Square, Liverpool. "Excavators." 5th August, 1887.

10771.—ALFRED JULIUS BOULT, of 323, High Holborn, London. A communication from Edwin Scott Field and Solomon Kingsbury Hindley, United States. "Magazine fire arms." (Complete specification.) 5th August, 1887.

10850.—ALFRED JAMES SHIRLEY, 245, Cable Street, St. George's in the East, London. "Switch or contact maker for electric lighting circuits." 8th August, 1887.

10866.—CARLOS ACCIOLI DE AZEVEDO BASTO, 52, Chancery Lane, London. "An improved motor." (Complete specification.) 8th August, 1887.

10870.—WILLIAM JOHN WILSON, The Woodbury, Kent Gardens, Ealing, W. "Photographic dry plates." 8th August, 1887.

10874.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Paul Sievert, Germany. "Glass furnaces." (Complete specification.) 8th August, 1887.

10888.—WILLIAM HENRY BRIGHTON, 13, Court Price Street, Birmingham, Warwickshire. "Improvements in and connected with ejector mechanism for breech-loading small arms. 9th August, 1887.

# Scientific News

## FOR GENERAL READERS.

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CONTENTS.



## CURRENT EVENTS.

The British Association Sectional Meetings.—The strong sprinkling of foreigners present had an appreciable effect on the sectional procedure. Not only did they take an active part in many of the discussions, but in several instances their mere presence caused greater attention to be given to the business conduct of the meetings. The number of papers was very large, and there was an evident determination to get through them punctually and systematically. So far therefore as the conduct of the sectional meetings was concerned, there was a marked improvement on last year; but there is a tolerably strong feeling that steps should be taken to keep the number of papers read within reasonable limits, and to exclude those which are not of sufficient merit. Above all, the practice of reading the same papers in more than one section should be stopped. The advertising instinct of certain pushing individuals is so keen that at times they over-estimate their importance, and do not hesitate to present their lucubrations in more than one section. This, however, is no reason why the audiences should be victimised, and if the rule were enforced that all papers proposed to be read should be sent in at least fourteen days before the meeting, and if they were then referred to revising committees, much valuable time would be saved, and fewer papers of inferior quality would then be read under the auspices of the Association.

Presidential Addresses at the British Association.—The President of the Mechanical Science Section quoted so experienced an authority as Sir Frederick Bramwell in support of a statement that the only purpose of an address is to force an audience to recall what it already knows. We cannot, however, but take exception to such a lowering of the aims of a presidential address, and are in fact surprised that it should be seriously advocated by men of culture and distinguished attainments. To quote from official sources, the main purpose of the Association is to bring together, from various and even remote districts, those who are engaged in scientific research, or who take an interest in scientific work. Obscure observers and unknown lovers of scientific culture are thus brought into more or less personal relation with the leaders of scientific thought. Surely on such an occasion a president should not content himself with a mere repetition of well-known facts, a mere historical *résumé* of what his audience is already acquainted with. Such a review is doubtless useful as a record of accomplished facts, but in these days of specialised work we cannot be satisfied with this alone.

All branches of science are so intimately associated, and are so interdependent, that it is of the greatest importance that every opportunity should be taken of bringing home to us the working of the unchangeable laws of Nature which govern our every action. We need direction and instruction by a well-informed, thoughtful leader, who not only has the power of generalisation and of co-ordinating the results of specialised work, but who can widen our range of vision, and lift us up, so to speak, from the mere cut and dried facts we are familiar with, to the contemplation of the laws of Nature which underlie them. Admirable as Sir Henry Roscoe's address was, as a rapid sketch of the progress of chemistry during the past fifty years, we cannot but think that he has lost a great opportunity in not bringing out more forcibly the grandeur and far-reaching importance of those generalisations which are the outcome of the highest scientific work, and which are so profoundly affecting modern thought.

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The Cost and Value of Food.—In a paper read by Professor Atwater at the recent meeting of the American Association for the Advancement of Science, he made a comparison of the physiological with the pecuniary economy of food. He reminded his audience that the cheapest food is that which furnishes nutrition at the lowest cost, but that the most economical food is that which is at once the cheapest to buy and the best adapted physiologically to the wants of the consumer. He then pointed out that, as a rule, vegetable foods are cheaper than animal food, but are not so highly nutritive. Flour is dearer to buy than potatoes, but taking into account their physiological value, the potatoes are less economical, because the proteid (the albuminous constituent) they contain is inferior and less digestible. In America, he said, the greatest waste occurs with beef, lamb, veal, fish, flour, potatoes, and fruit; but there is good reason to suppose that these articles of food are just as much wasted in many European countries. The waste of food in our own homes is indeed proverbial, and it is especially striking if account be taken of the small proportion which the food actually eaten bears to the total weight bought, or even to the net weight after being cooked. There is little doubt that nearly all classes buy more than they need, and what they buy is often badly selected for the physiological ends in view.

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A large excess is actually thrown away, and when we add to this the loss due to careless storing, bad cooking, and unskilful use, some idea may be formed of the enormous waste which is going on. As bearing on this question, we remember hearing one of our largest makers of mustard state somewhat paradoxically that the extent of his business depended much more on the quantity of mustard unused than on that consumed. Great, however, as is the financial loss, Prof. Atwater considers the physiological waste still greater, and he is of opinion that more harm is done by unwise eating and drinking than can be estimated. The rich, he says, suffer both in health and purse, but the poor suffer most of all, because the food of the labouring classes is relatively large in amount and costly in kind. Again, costly materials are used when less expensive would do as well, and false economy is practised in buying what seems to be cheap, but is in reality dear. It should be remembered, too, that all food wasted enhances the price of the food actually consumed, for it costs as much to produce food which is wasted as that which is used, and the total cost of production has to be borne by the proportion of food eaten. That plenty often makes waste is within the experience of all of us, but that is only a greater reason why we should use every endeavour to prevent its continuance.

Thermo-Electricity.—It has long been known that an electric current can be produced by heating the point of contact of two dissimilar metals. For instance, if a piece of bismuth and a piece of antimony be soldered together, and if the unsoldered ends be connected with a copper wire, a current will be set up on the soldered ends being heated. Thermopiles consisting of several pairs of metals joined together in series have been constructed on this principle, but their efficiency is extremely low, and to produce a current suitable for electric lighting, it would not only be necessary to have a large number of batteries to obtain the electro-motive force required, but the expenditure of fuel would be excessively high for the current produced. For practical purposes, therefore, it is better to use a dynamo-electric machine, or acid batteries. For the latter, the renewal of the acid involves much trouble and expense, and for the former, engine power is required. It is, however, admitted by competent authorities that with the best steam-engine and boiler only ten per cent. of the heat energy of the fuel is converted into useful work at the engine. There is then a further loss of power in the dynamo itself, and roundly it may be said that, with the best boiler, engine, and dynamo, only about one-twelfth of the heat energy of the fuel burnt is converted into electrical energy.

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Mr. Edison has just devised an apparatus by which he claims to have made a considerable step forward in the direct conversion of heat into electricity. He abandons the ordinary thermopile, which has such a low efficiency, and he calls to his aid the fact that the magnetisation of the magnetic metals is strongly affected by heat. In the apparatus he has recently brought to the notice of the American Association there are eight electro-magnets, each having a hollow core or keeper of sheet iron. These cores are successively heated and cooled, and in this way a magnetic current is set up in each, one after the other, and it is for this reason that the apparatus is called a pyro-magnetic generator of electricity. The cores are heated by the products of combustion of a fire below, and they are cooled by a current of cold air drawn in by the chimney draught. The idea is certainly ingenious, but the subject is an extremely complex and difficult one to deal with, and what the outcome of it may be it is too soon to conjecture. Doubtless careful trials will be made, and we sincerely trust that it may be proved that we are nearer the solution of one of the greatest questions of the day—the direct conversion of heat into electricity without excessive loss or expense.

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Science in the United States.—In commenting on the recent meeting of the American Association, the *New York Tribune* draws attention to the increasing importance of science in daily life, and to the fact that this is now generally acknowledged to be the case. To the popular understanding, scientific agriculture used to be thought a mere waste of money in chimerical experiments; but in these days the farmer himself begs the Weather Bureau, the entomologist, the chemical analyst, to aid him at every step. The *Tribune* remarks that now manufacturers of iron and steel do not dream of achieving great success without the aid of a scientific chemist, and that more steel is made in the United States than in any other country, "because it puts more knowledge into the converters." It adds, moreover, that the United States has led the world in the applications of electricity, and that France, Germany, Great Britain, and Austria have altogether only about as many miles of wire in use as the United States. Allowing for a little exaggeration in these statements, there can be no doubt that science has indeed done great things for America, and that the nation is becoming keenly alive to its importance. Much, however, remains to be done, and it may be that science would secure still larger appreciation and support in all countries if more effort were made to bring scientific principles and the steps of scientific progress to the comprehension of a larger number of the people.

TECHNICAL EDUCATION.—We cannot help feeling that some of the advocates of technical instruction are now greatly exaggerating the effect it will produce on our artisans as regards their actual work. Without doubt, whoever learns the principles on which any process of manufacture is based, is thereby intellectually improved, and is better fitted to deal with its practical development than if he were without such a training. To suppose, however, that such a knowledge of principles can be acquired in adult life by minds previously untrained, is to shut one's eyes to the teaching of everyday facts. Moreover the little time at the disposal of working men, for obtaining such knowledge renders it impossible for them to deal thoroughly with any subject. We are entirely in favour of technical instruction of the young, if by this is meant a training to prepare their minds for understanding more of what will come before them as work in after life. Such a training is excellent, but it is expecting too much to suppose that it will have any great effect on the daily work of bread-winning. The essential, as far as progress in manufactures, etc., goes, is that masters and managers of works should have a thorough technical training, so as to take every possible advantage of the teaching of science, as bearing on the work they have in hand. This is the crux of the whole question, and it is because our managers have so neglected this part of their training, that the better-trained foreigners have in many instances overtaken them.

Our experience leads us to think that in most walks in life the average worker, whether intelligent or not, gets through his daily work without caring anything whatever about the science underlying it. Even when the work to be done involves a scientific training there is little or no scientific thought, in the full meaning of the term, given to it. At the British Association meeting, Mr. William Mather read a thoughtful paper on Manual Training as a main feature in national education, an abstract of which we give elsewhere. He made several very telling statements, but he spoilt a good cause by so exaggerating the probable results of technical training as to talk of farm labourers being able to do their work better if they learnt the elements of science underlying successful husbandry! By all means let the farmers and squires learn the science of farming, so as to make the best possible use of the bounties of nature, but let the labourers be content to learn how to perform their work in the most intelligent and skilful manner, without attempting things too high for them. Let the children of the working classes seek the best instruction they can get, but do not let any one have the false notion that he has mastered the science of his work when, in truth, he has but a parrot-like acquaintance with it. According to Mr. G. H. Lewes' admirable definition, science is the systematic classification of experience, and a thoughtful person must see at once that anything like a rapid or superficial treatment of it is of necessity inadequate.

SCIENCE AND LITERATURE.—Speaking at Newcastle on the University Extension Lectures, Mr. John Morley made some excellent remarks on the subject of science and literature. He said he was one of those who believed that the greatest question affecting our national future lay in the extension and improvement of technical instruction. He was far from thinking that this movement would be impeded by the diffusion of science and literature, and he was persuaded that the general activity of intellect which it was the aim of university teachers to promote was the very best preparation for making workmen and artisans profit by technical instruction when it is brought within their reach. University education, as he understood it—namely, the combination of science and literature—had been of vast service. He had never felt that there was any of that conflict of which they had read a great deal, between science and literature; so far from being antagonistic they were mutually helpful. He thought it would be a great mistake not to put literature in as prominent a place as science, because literature gave the ideas which guided conduct, raised method, and enriched character; and it was upon conduct, method, and character that the future of the nation would depend.

DUCTILITY OF PLATINUM.—It has been found that platinum wire can be drawn so fine as to be invisible to the naked eye, although its presence upon a perfectly white card can be detected by the touch, and can be seen by the aid of a small magnifying glass when the card is held in such a position that the wire casts a shadow.

KING'S COLLEGE.—We understand that the subject for the essay which forms the special portion of the work for the gold medal and prize, founded by Sir William Siemens for the metallurgical students of King's College, London, will this year be "Gaseous Fuels: their Manufacture, Composition, Properties, and Uses." The essays must be sent in to Professor Huntington before 16th June, 1888. The award will be made on the essays, on the results of the College examination in metallurgy, and on the practical work in the laboratory of the College.

## GENERAL NOTES.

Anthracite in Eastern Ontario.—Samples of the anthracite recently discovered in Eastern Ontario have been tested, and are reported to be of the best hard quality. The coal-beds are near the large iron-mining district in the same locality, and experienced miners from Pennsylvania are expected to examine the district.

Apparatus for Seeing Objects under High Pressure.—An apparatus made of iron and glass, in which a pressure of 1,000 atmospheres can be developed, for the purpose of studying the influence of great pressure on animal life, has been exhibited to biologists in France. With it deep-sea animals can be observed under their natural compression.

The Cultivation of Roses.—From the *Western Bulletin* we learn that roses grown for perfume are the common pink ones. They are cut low, and the ground between the trees enriched with manure. The flowers are gathered as soon as the dew has disappeared, and after the plant is through bearing blossoms the stem is cut to within a few inches of the ground in order to conserve the vigour of the plant.

Effect of Heat on Pianos.—The heat of a fire is very likely to put a piano out of tune. This is not due to the expanding and contracting of the strings, as generally supposed, but to the variations produced in the sounding-boards under the influence of the increased dryness of the air, especially in furnace-heated houses. Sounding-boards are made of spruce, because of the superior resonance of that timber; but spruce, of all woods, is most affected by changes in temperature.

Blindness in the United States.—According to Prof. Howe, the population of the United States has increased 30 per cent. during the decade 1870 to 1880, whereas blindness has increased 140 per cent., and he says that the support of the blind now costs the country over twenty-five million dollars per annum. This is certainly a very startling statement, and we are tempted to think that during the previous years with which the decade is compared, the records of blindness were not so accurately kept as at present.

Watch Glasses.—We learn from the *Horological Journal* that the watch glasses which are now used are moulded by a process which was invented in 1791, by Pierre Royer, a Parisian manufacturer. C. Launier gives an interesting description of one of the large factories, and of the different processes of manufacture. Two and a half million watches are now made annually, and more than seventy millions have been sold within the last half century. On account of the large consumption, and the large stocks which every watchmaker requires to keep on hand, the annual product of watch glasses cannot be less than a hundred million.

A New Milk Test.—According to the *Lancet*, a new test for milk has been proposed. This test depends upon the fact that a certain chemical—the sulphate of diphenylamine—is coloured blue by the presence of an extremely dilute solution of nitrate. As well water contains more or less nitrate, its presence in suspected milk can easily be ascertained by the use of this chemical. To use this test a small quantity of the sulphate is placed in a porcelain cup, and a few drops of the suspected milk are added to it. The mixture will speedily show a blue tinge if the milk contains even 5 per cent. of average well water.

A House-building Fish.—In Lake Nyassi, in the far interior of Africa, is a kind of black fish which every year builds what the natives call "a house." In the mud at the bottom of the lake it makes a hole some two or three feet broad, allowing the earth removed from the hole to form a little wall around it. The depth of the hole and the height of the wall, measured together, make a small basin from fifteen to eighteen inches deep. In this little lake within a lake the fish feels secure from all enemies, and quietly keeps house until the eggs are laid, when it becomes restless and leaves the house as a nursery for successors, while it roams about again at will.

The Effect of Oil on Waves.—Some important experiments are about to be made officially, in France, by naval officers in charge of ten different ships of war on the effect of oil on waves. Similar experiments are now being carried on by the Central Salvage Company at Dunkirk, Calais, Audierne, and other stations along the coast. It is expected that the results obtained will be such as to render the use of oil general in saving life from wrecks. The trials which are being made are intended rather to prove the efficiency of the apparatus employed to distribute the oil than the efficacy of the oil in stilling the waves, which has already been sufficiently demonstrated.

A Priest-Soldier-Scientist.—A young Catholic priest and scientist, of Charleston, Illinois, who was recently created a lieutenant in the French army for valuable discoveries in the art of making and using a powerful explosive for war purposes, claims to have made a more valuable discovery, or rather rediscovery. He says he has fathomed the art of making Greek fire, which was lost in the Middle Ages, about 1250, when gunpowder came into use. The compound consisted of naphtha and two other ingredients, and its power of destruction is marvellous. It will so corrode iron as to dissolve it, while water, instead of extinguishing it, will only increase its power. The inventor will soon publish an article on the subject of his great discovery.—*Chemist and Druggist.*

The Diet of Strong Men.—The Roman soldiers who built such wonderful roads, and carried a weight of armour and baggage that would crush the average farm labourer, lived on coarse brown bread and sour wine. They were temperate in diet and regular and constant in exercise. The Spanish peasant works every day, and dances half the night, yet eats only his black bread, onion, and water-melon. The Smyrna porter eats only a little fruit and some olives, yet he walks off with his load of a hundred pounds. The coolie, fed on rice, is more active and can endure more than the negro fed on fat meat. The heavy work of the world is not done by men who eat the greatest quantity. Moderation in diet seems to be the pre-requisite of endurance.—*Scientific American.*

A Garden Barometer.—One of the simplest of barometers is a spider's web. When there is a prospect of rain or wind, the spider shortens the filaments from which its web is suspended, and leaves things in this state as long as the weather is variable. If the insect elongates its threads, it is a sign of fine calm weather, the duration of which may be judged of by the length to which the threads are let out. If the spider remains inactive, it is a sign of rain; but if, on the contrary, it keeps at work during rain, the latter will not last long, and will be followed by fine weather. Other observations have taught us that the spider makes changes in its web every twenty-four hours, and that if such changes are made in the evening, just before sunset, the night will be clear and fine.—*La Nature.*

Inventions of Different Nations.—An American contemporary, commenting on the progress made by America, says, the telescope and microscope we owe to Holland; printing and the spectroscope to Germany; photography, chemical analysis, and the electro-magnet to France; the amalgamation of ores to Spain; the chronometer, the steam-engine, the fly-shuttle and loom, the general development of iron—by rolling-mill, hot blast, and smelting-furnace—the stereotype, illuminating gas, and the Bessemer process of steel-making, to Great Britain; while the United States, youngest of all, claims the cotton-gin, steamboat, reaping-machine, sewing-machine, type-casting, the electric telegraph, vulcanised rubber, the friction match, the steam fire-engine, the street railway, and revolving fire-arms.

Soldering Cast Iron with Tin.—Many ornamental articles are made of cast iron, variously decorated, but the smaller specimens of this kind break very easily if carelessly handled. The question then arises how to mend the broken article, a question that has puzzled many, as it is so very hard to unite firmly pieces of cast iron, because it has but a slight affinity for tin solder. The soldering can be made much easier by first cleaning the faces of the broken parts from all impurity, unless the fracture is of recent occurrence and the broken parts are perfectly clean. With a brass wire brush, the faces of the fracture are then rubbed until they appear yellow, and are so to speak "dry plated" with brass. The surfaces are then tinned, just as brass is tinned, and the parts can be soldered together without difficulty.—*Der Metallarbeiter.*

Why Snow Destroys Marble Statuary.—From the *Pharmaceutical Journal* we learn that the results of the examination of snow taken from different places in Munich and its neighbourhood by Mr. Sendtner, would seem to indicate not only that snow has a considerable faculty for absorbing sulphurous acid from the atmosphere, but that the absorption goes on continually for some time. Mr. Sendtner ascertained that, on one day when snow fell, sulphurous and sulphuric acids were present in it in fairly equal proportions, but on the second day almost all the sulphurous acid had been ozonised to sulphuric acid. In the vicinity of chimneys and gas works the absorption would of course be greater. This great absorptive power for sulphurous acid is considered of great practical interest as explaining the destructive action of snow on marble statuary.

Definition of Science.—A contemporary remarks that the present generation is crying out loudly for a scientific education for the working-classes, to enable them to compete with the better educated workers of other lands; but there is a marked difference of opinion as to what "science" means. Sir William Hamilton defines science as "a complement of cognitions, having, in point of form, the character of logical perfection, and, in point of matter, the character of real truth." Herbert Spencer defines science as "a higher development of common knowledge," and most scientific people agree with the statement that science is, pure and simple, "organised common sense." The wider the definition the better, but the definition adopted in some schools is peculiar, and the results are disastrous to every attempt made to organise the common sense of the unfortunate pupils, for the system of "cram" is used under the sacred name of science.

The Motive Power of the World.—From a note published by the Bureau of Statistics in Berlin the following very interesting figures are taken. Four-fifths of the engines now working in the world have been constructed during the last five lustra (25 years). France has actually 49,590 stationary or locomotive boilers, 7,000 locomotives, and 1,850 boats' boilers; Germany has 59,000 boilers, 10,000 locomotives, and 1,700 ships' boilers; Austria, 12,000 boilers, and 2,800 locomotives. The force equivalent to the working steam engines represents in the United States 7,500,000 horse-power, in England 7,000,000 horse-power, in Germany 4,500,000, in France 3,000,000, in Austria 1,500,000. In these the motive power of the locomotives is not included, whose number in all the world amounts to 105,000, and represent a total of 3,000,000 horse-power.

Paper Roofing.—It is said that compressed paper pulp has been used in America for the covering of roofs. The advantages claimed are lightness, which obviates the necessity of the present heavy frame support; a toughness and elasticity not possessed by slate, rendering breakage an impossibility; a singular power of resistance to intense heat or flame; and a readiness to receive nails, which bind it compactly to the bed, and so closely together that high winds will not loosen or cause them to shift, as is frequently the case with slate tiling. The process of manufacture is very simple. The mould is first prepared, into which the pulp is pressed and allowed to partially dry. The crude tiles are then dipped into a solution to harden their fibres and render them waterproof. When thoroughly impregnated they are dried by baking in an oven heated to a special temperature, then coated with an enamelling mixture, upon which is sifted a thin coating of fine sand, coloured according to the tint desired, to fireproof them. They are subjected to heat a second time, and are then ready for use.

Meteorite in New York.—According to the *New York Times*, something resembling a meteorite struck the sidewalk in Brooklyn, at Troy and Fulton avenues. When first seen it was said to have resembled a ball of about the size of a man's head, but was broken into fragments by the fall. The substance is of a bright vivid green and porous. When first procured it was soft and plastic, taking the impress of the fingers. After remaining over a day it became brittle and friable. It resembles precisely in appearance the green deposit left on a battery. At first it was thought that the lightning had struck a copper wire or roof, had melted portions of it, and, oxidising it, had carried it to a great distance. Analysis showed its probable meteoric source, as it gave with the reagents and the blowpipe unmistakable evidence of the presence of cobalt and nickel, which twin metals are always found in meteorites. There were no traces of copper, and faint indications of iron. From the quantity of the material it is thought that the ball when intact must have weighed twenty pounds. Portions have been sent to the Smithsonian Institution.

Windmills for Electric Lighting.—Experiments are being made at Cap de la Hève, near the mouth of the Seine, on the production of electricity for lighthouse purposes by means of the power obtained from windmills. The suggestion to do so was made by the Duc de Feltre, and it is a system proposed by him that is to be tested. The wind works a dynamo-electric machine employed in charging accumulators of suitable capacity. The electricity so produced and stored is to be used at will as a source of light. The system, if successful, will have the advantage of involving only the cost of putting up of the machinery. The whole question to be ascertained is whether a sufficient quantity of electricity can be stored to provide for the requirements of any particular station when there is no wind to move the sails of the mill. M. de l'Angle-Beaumanoir, a civil engineer at Paris, has been authorised by the Minister of Public Works to make, at the expense of that department, a trial of this system of electric lighting at the La Hève lighthouse. The experiments will in no way endanger or inconvenience navigation, as the present machines are ready to be used should the new system fail to work.

A Long-surviving Fallacy.—We are told by the *Farming World*, that an English experimenter finds that, contrary to general opinion, the growth of ivy over a house renders the interior entirely free from moisture; the ivy extracts every possible particle of moisture from wood, brick, or stone for its own sustenance, by means of the tiny roots which work their way even into the hardest stone. Of course it does! For my own part I am heartily ashamed of requiring to be told of so obvious a fact, and hope that every reader of *Science Gossip* who has not already reasoned it out for himself will be equally penitent. Every leaf of every plant that grows is largely composed of water, and every such leaf is continually exhaling gaseous water, and this water is supplied by rootlet absorption. The ivy differs from ordinary plants in having rootlets on every stem, thus rendering it almost independent of its main ground root. Its notorious killing action upon growing trees when it takes full possession of them is mainly due to absorption of their juices. If there is any juice in a stone or brick wall, *i.e.*, any moisture, the ivy must have it. Besides this, the ivy directly protects the wall from the wetting action of raindrift.—*Science Gossip.*

Experiments with a Candle.—Put a lighted candle behind a bottle, pickle-jar, or any other object having a polished surface, then station yourself at about twelve inches from the object, so that it hides the flame of the candle from you, and blow with your breath. The candle will be very easily extinguished, in consequence of the currents of air that you have created around the object meeting near the flame. With a board or sheet of cardboard of the width of the bottle, extinction would be impossible. This experiment has a counterpart that has been communicated to us by M. Harmand, of Paris. Take two bottles instead of one, and place them alongside of each other, so as to leave a space of half an inch between them. Place the candle opposite this space, and preserving the same distance as before between your mouth and the candle, blow strongly against the flame. Not only will the latter not be extinguished, but it will incline slightly toward you, as if through the effect of suction. This phenomenon, which is analogous to the preceding, is due to the fact that as a portion of the air cannot pass between the bottles, it flows around their exterior and returns to the operator.—*Le Chercheur.*

The Chemical Composition of Man.—From a chemical point of view, man is composed of thirteen elements, of which five are gases and eight are solids. If we consider the chemical composition of a man of the average weight of 154 pounds, we will find that he is composed in large part of oxygen, which is in a state of extreme compression. In fact, a man weighing 154 pounds contains ninety-seven pounds of oxygen, the volume of which, at ordinary temperature, would exceed 980 cubic feet. The hydrogen is much less in quantity, there being less than fifteen pounds, but which, in a free state, would occupy a volume of 2,800 cubic feet. The three other gases are nitrogen, nearly four pounds; chlorine, about twenty-six ounces; and fluorine, three and a quarter ounces. Of the solids, carbon stands at the head of the metalloids, there being forty-eight pounds. Next come phosphorus, twenty-six ounces, and sulphur, three and a quarter ounces. The most abundant metal is calcium, more than three pounds; next potassium, two and a half ounces; sodium, two and a quarter ounces; and lastly, iron, one and a quarter ounces. It is needless to say that the various combinations made by these thirteen elements are almost innumerable.—*Le Practicien.*

Arrangement of Museums.—The Biological and Geological Sections of the British Association met together to discuss the question of the arrangement of museums. The matter was introduced by Dr. Woodward in an interesting paper, in which he said that, although it might seem a simple question, the arrangement of museums had occupied the attention of naturalists for many years. He advocated the placing of recent and fossil forms of each group in near proximity—say, in a series of parallel galleries adjoining each other, or in parallel rows of cases. Prof. Haddon said that people who visited the British and other large museums always leave with sore feet and sore heads, owing to the large number of specimens they were supposed to study. He believed in few specimens for a public museum, but there could not be too large a series for the purposes of the student. Prof. Boyd-Dawkins said that in the new museum of Owens College an endeavour would be made to arrange the specimens in the best manner to suit all wants. The discussion was continued by many leading geologists, and the general conclusion seemed to be that some compromise should be effected between the two extreme views, and that the student of recent forms should not neglect the fossils, any more than the palæontologist should ignore the knowledge gained by the observations of living forms and existing phenomena.

Multiplication of Living Beings.—Mr. Darwin has told us that "There is no exception to the rule that every organic being naturally increases at so high a rate that, if not destroyed, the earth would soon be covered by the progeny of a single pair. Even slow-breeding man has doubled in twenty-five years, and, at this rate, in less than 1,000 years there would literally be no standing room for his progeny." If all the offspring of the elephant, the slowest breeder known, survived, there would be in 750 years nearly nineteen million elephants alive, descended from the first pair. If the eight or nine million eggs which the roe of a cod is said to contain developed into adult codfishes, the sea would quickly become a solid mass of them. So prolific is its progeny after progeny, that the common housefly is computed to produce twenty-one millions in a season; while so enormous is the laying power of the aphis, or plant-louse, that the tenth brood of one parent, without adding the products of all the generations which precede the tenth, would contain more ponderable matter than all the population of China, estimating this at 500,000,000. It is the same with plants. If an annual plant produced only two seeds yearly, and all the seedlings survived and reproduced in like manner, one million plants would be produced in twenty years from the single ancestor. Should the increase be at the rate of fifty seeds yearly, the result, if unchecked, would be to cover the globe in nine years, leaving no room for other plants. The lower organisms multiply with astonishing rapidity—some minute fungi increasing a billionfold in a few hours; and the *protococcus*, or red snow, multiplies so fast as to tinge many acres of snow with its crimson in a night.

Degeneration of the Teeth.—An article recently published in an evening contemporary very properly criticises the theory started in an American dental journal that vegetarian diet would, if universally adopted, produce an edentulous condition of the jaws in the course of a few generations, utterly regardless of the fact that vegetarian races have magnificent teeth. The pathology of this condition is stated to be *disuse* and consequent atrophy of muscles and jaws, then degeneration, and ultimately suppression of the teeth entirely. That comparatively little employment of teeth has something to do with their degeneration in civilised nations admits of no doubt; but how many thousand years must it take to make men edentulous when there are so few evidences of a tendency in that direction. The wisdom teeth are said to be disappearing because they are so often ill-developed and frequently never erupted, and the same remark may sometimes be applied to the upper lateral incisors; but many Egyptian mummies and Etruscan skulls two thousand years of age exhibit the same conditions, yet there is no race of men edentulous. "Are the teeth of the present century worse than those of the last?" is a quesion by no means easily answered, for we have only general observations and no statistics to go by. Dental surgery is a modern art, and too much separated from its parents—medicine and surgery—to satisfactorily decide the question. Moreover, dentists only see those people who have defective teeth. Again, much more importance is attached to teeth than in former days, and they consequently receive more attention. It has often been pointed out that the vast improvements in medical and surgical treatment serve to keep alive a large number of weaklings who would otherwise have died, and these often have a progeny of similar frailty, whose teeth we may legitimately conclude partake of the general infirmity. On the other hand, dental disease, if early treated, as is now done, may be to a great extent stamped out. Of course, the teeth of civilised nations are worse than those of savages, although, as has been remarked in our columns, those of the latter are by no means free from disease.—*Lancet.*

LIGHTNING CONDUCTORS.—Professor Tyndall lately addressed the following letter to the *Times*:—Some years ago a rock lighthouse on the coast of Ireland was struck and damaged by lightning. An engineer was sent down to report on the occurrence, and as I then held the honourable and responsible post of scientific adviser to the Trinity House and Board of Trade, the report was submitted to me. The lightning conductor had been carried down the lighthouse tower, its lower extremity being carefully embedded in a stone, perforated to receive it. If the object had been to invite the lightning to strike the tower, a better arrangement could hardly have been adopted. I gave directions to have the conductor immediately prolonged, and to have added to it a large terminal plate of copper, which was to be completely submerged in the sea. The obvious convenience of a chain as a prolongation of the conductor caused the authorities in Ireland to propose it, but I was obliged to veto the adoption of the chain. The contact of link with link is never perfect. I had, moreover, beside me a portion of a chain cable through which a lightning discharge had passed, the electricity in passing from link to link encountering a resistance sufficient to enable it to partially fuse the chain. The abolition of resistance is absolutely necessary in connecting a lightning conductor with the earth, and this is done by closely embedding in the earth a plate of good conducting material and of large area. The largeness of area makes atonement for the imperfect conductivity of earth. The plate, in fact, constitutes a wide door through which the electricity passes freely into the earth, its disruptive and damaging effects being thereby avoided. These truths are elementary, but they are often neglected. I watched with interest some time ago the operation of setting up a lightning conductor on the house of a neighbour of mine in the country. The wire rope, which formed part of the conductor, was carried down the wall, and comfortably laid in the earth below, without any terminal plate whatever. I expostulated with the man who did the work, but he obviously thought he knew more about the matter than I did. I am credibly informed that this is a common way of dealing with lightning conductors by ignorant practitioners, and the Bishop of Winchester's palace at Farnham has been mentioned to me as an edifice "protected" in this fashion. If my informant be correct, the "protection" is a mockery, a delusion, and a snare.

FIRE-PROOF FABRICS.—The *Lancet* remarks that it has long been known that all fabrics, even the most delicate gauzes and muslins, may be rendered uninflammable by chemical treatment. Of course they cannot be made incombustible, but they can easily be so prepared as to be incapable of bursting into flame. The chemical agents employed act by checking and modifying the destructive distillation which precedes what is properly known as inflammation. The chemicals most commonly used for the purpose are alum, borax, phosphate of soda, sal-ammoniac, and tungstate of soda. Alum acts injuriously on the fabrics, especially if coloured, but the others are commonly harmless, and most of them are cheap. Tungstate of soda is the best. Used singly it is apt to become insoluble and to rub off, but this risk can be diminished by the addition of about 3 per cent. of phosphate of soda. After the ordinary washing, the goods should be immersed before wringing and drying in a solution containing 20 per cent. of tungstate with a proportionate quantity of phosphate.

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## THE DUST IN THE AIR.

WE might suppose that with no dust in the air we should at least have more light; but while it is undoubtedly true that the sunbeams show us the motes, it is no less true also that the motes and fine dust actually show us the sunbeams, and that one is invisible without the other. A beam of sunlight or electric light, if admitted into a chamber in which the air is perfectly pure, at once *disappears*, and is replaced by pitchy blackness, except where it strikes the wall or some other object. Balloonists tell us that the higher they ascend the deeper becomes the colour of the sky, until at the height of a few miles it looks almost like a black canopy, because, though the sun is shining in unclouded splendour, there is little or no dust to scatter his light. The space between the stars—inter-stellar space, as it is called—is, accordingly, absolutely black, notwithstanding the blaze of light which passes through it and becomes visible on striking our dusty atmosphere.

The dust in the air we breathe is kept out of our lungs, where it would be injurious, by the innumerable fine hairs or *cilia* which cover the air passages, and filter the air; but when the strain is too great and prolonged, the hairs cease to act, the membrane of the air passages becomes inflamed, and bronchitis or asthma follows. The dust of coal mines and that caused by grinding, especially steel-grinding, and the polishing of pearl buttons, marble, etc., particularly where emery is used; also the dust in potteries and china works; the organic dust and fluff of shoddy and flax mills, as well as that arising from the sorting of type, are all injurious, and some of them fatal, in their effects upon the air passages and lungs, which the hairs are quite unable to protect. A seedsman once complained to Professor Tyndall that his men were made quite ill during the busy season by the irritation produced by the dust from the seeds, and gladly accepted his suggestion that they should be provided with respirators made of cotton wool tied up in muslin, which filtered the air so perfectly that no further complaints were heard. The "black lungs" of colliers are well known, and stony dust is found deposited in the lungs of some masons; but under ordinary circumstances, except in large towns, the natural filtering apparatus is quite effectual, the particles being arrested by the hairs above-mentioned and then sent back into the air by the expired breath. The air which we breathe out at the end of an expiration is so absolutely free from dust that if we breathe across the track of an electric beam the latter will be pierced by an intensely black hole, for the reasons already given.—*New South Wales Independent.*

## CARRIERS OF INFECTION.

SAID an acquaintance to us the other day, in a very doleful tone :—" How comes it, that in spite of all precautions, I have twice had infectious diseases occurring in my family within the last twelve months ? I have done everything which you sanitary reformers recommend. I live, as you know, in an open, airy locality at some distance from any crowded slums or sources of nuisance. The drainage of my house has been examined by an expert and pronounced to be above suspicion. The water cistern is clean, and is not in any connection with the gases from the soil-pipe. All the plumbers' work about the premises is in good condition. The dust-bin is regularly emptied, and no substances capable of putrefaction are ever thrown into it. We dose the sinks with the most approved disinfectants, whilst as to ventilation and cleanliness my wife is almost too diligent. Yet in spite of thus fulfilling all known duties I have had the measles among my children eight months ago, and the house-maid was even attacked with diphtheria."

These words reminded us that there are channels of infection less easily cut off than neglected sewers and foul dust-bins, and against which the individual citizen and the public authorities are almost equally powerless.

To take a case which has been known to happen, and which may recur at any time or in any place. Suppose the courteous reader orders a suit of clothes at his tailor's—whether it may be at the West-end or at the East-end it matters little. These garments are, save in exceptional cases, not made up in clean, well-aired work-rooms. The cloth cut out is sent to be sown in the dens of " sweaters " and their victims. There the work is done in close, over-crowded apartments, where the working-tailor and his family sleep, live—and die.

Your superfine frock-coat may serve to cover the bed of a child sick of small-pox, of scarlet fever, or of any infectious malady. For a full and truthful account of the perils to which public health is exposed through this system, our readers are referred to the late Canon Kingsley's eloquent description in " Alton Locke." But if you smell carefully at a new coat when it has been sent home you cannot doubt but it has been in an exceedingly foul atmosphere.

One of not the least urgent duties of society is to declare and maintain a war of extermination against the " sweating-system " in the tailors' business. Meantime it is a good precaution never to put on a new article of dress as soon as it comes home. Let it hang for a few days exposed to the air.

Turn we to another of these unsuspected " carriers " of disease and death. Suppose any person above the age of childhood is recovering from some infectious sickness, but is not yet able to go to business. As a pastime the almost universal resource is reading. Books are accordingly procured from the nearest library and are duly devoured. But unfortunately the stage of convalescence is in some diseases, such as small-pox and scarlet fever, precisely the time when the risk of infection is greatest. The books when read are duly returned to the library, to all appearance perfectly clean. They are then lent to other persons, and these latter, if susceptible to that particular infection, find themselves unaccountably taken ill. The doctor asks whether the patient has been at any house where the sickness has occurred, and finds that such is not the case.

A culpable recklessness is often shown by persons who are in immediate contact with the sick, or even in actual attendance upon them. Such persons will often go to shops to purchase articles not immediately necessary ; they will travel in public conveyances, go to church, and in numbers of ways endanger the health of their neighbours. We have more than once heard a child whooping violently during morning service at our parish church, to the no small peril of any other children who may be seated near.

As regards railway-carriages, cabs, tram-cars, etc., the law does interfere if the case is known. But very often the offender is never suspected, and neither precaution nor punishment can be brought to bear. Here the only safeguard lies in the conscientiousness of the public, which can operate only when the said public becomes more enlightened than at present. Did space allow, we could give the particulars of an instance of this kind which led to at least one death.

Another mysterious cause of infection is connected with the laundry. In multitudes of families dirty linen is sent out to be washed. The persons who carry on this business are not, as a rule, either aware of, or heedful of, sanitary considerations. The under-garments, bed-linen, etc., of a healthy family may be mixed up with those from a household where some communicable disease prevails. Disinfectants are rarely used, and it is by no means certain that disease-germs, if present, will be inevitably destroyed by the hot water and the soap used in washing, or the heat applied in drying.

But how stand matters if the " week's wash " is not sent out to some public laundry, but attacked at home. This system, in London at least, involves the services of one of those good ladies who go out washing, since the average servant-maid has a soul above soap-suds.

Now, the professional washerwoman often lives in some unhealthy and overcrowded dwelling. She often carries about her person that peculiar and unpleasant odour of " stuffiness " which tells at once its tale of her habits and surroundings. More than this, she may, for anything you know, have been engaged yesterday in washing the bed-linen of some person who has just died of fever. Hence her visits, like those of the charwoman, are never certainly and absolutely safe. Ninety-nine times she may come and go leaving you unscathed. The hundredth time she may leave you something to be sadly remembered a dozen years to come.

There is another insidious danger. You find it desirable to remove, and you select one of those newly-built residences, " replete with every modern convenience," which are advertised in all the morning papers. Here, surely, you feel safe that you can have had no dirty, careless predecessors, and that no morbid matter is at hand ! Or you may find it necessary to repair, alter, or enlarge your house. What danger can be here met with ? So thought lately a nobleman, who caused a new wing to be added to his mansion in the country, chiefly to provide better accommodation for his servants. To the surprise of his lordship, no less than that of his architect and his medical adviser, the new wing proved to be a hospital ! Servant after servant sickened of small-pox. This was the more remarkable as no cases of small-pox had occurred in the cottages on the estate. All the villages for some miles round showed a clean bill of health. Whence, then, the infection ? The villainous contractor who had built the wing, instead of using sound, honest timber, had bought up the woodwork of a number of houses condemned as unsafe, and, after having it planed over, had used it in constructing the wing above-mentioned.

This, we understand, is no uncommon piece of iniquity, and may serve as a key to not a little unaccountable sickness and death in newly-built houses, where no other channel for the access of infection can be traced. Condemned houses, especially in the older and more disreputable parts of London, and of other great cities, are likely to have become saturated with infectious matter, and the destruction of all the woodwork by fire ought to be enforced by law. We are not sure, even, that the very bricks are sufficiently safe to be used, as they often are, for building the internal walls of houses.

We come next to domestic animals of various kinds. Cows are believed to be liable to a form of scarlet fever which does not seem greatly to affect their own wellbeing, but which is communicable, through their milk, to human subjects. They are also liable to tubercular disease, especially when aged, and the use of their milk, when in that condition, may lead to pulmonary consumption. Cats are liable to diphtheria, and may communicate this horrible disease to children who play with them and receive their breath. Poultry and, we believe, pigeons are subject to the same scourge. One instance is on record of a canary-bird dying with evident symptoms of scarlet fever. The most loathsome and intractable of all known diseases, glanders, though it originates among horses, is, unfortunately, capable of transference to mankind. It is exceedingly imprudent to drink out of any trough from which a horse can have been drinking.

We may remark that the penalty for leading or driving a glandered horse along any public road is ridiculously trifling. A drop of the secretion from the animal's nostrils blown by the wind into the face of a passer-by may doom him to a fearful death.

But of all the unknown and disregarded channels of infection the most powerful are certain insects—those, namely, which beset us and creep upon our food and our persons. These insects belong mainly to one group, the Diptera, or two-winged flies. Of these, multitudes are at one moment feasting upon the most repulsive substances, the carcases of dead animals and morbid products, and the next we find them settling upon our food. It has been ascertained that, *e.g.*, the common house-fly can and does swallow disease germs, but these pass uninjured through its digestive organs, and are deposited by it in places where they may prove very dangerous. Thus by their agency infection is conveyed from place to place. Still more noxious than the common fly and its immediate kindred are the blood-suckers, gnats, mosquitoes, sand-flies, etc., which positively inoculate us with the poison of various diseases. In this manner malarial fever, leprosy, malignant pustule, and probably yellow fever are propagated. As regards malignant pustules, often called carbuncle, the evidence is particularly clear. A man finds himself bitten by a fly; the bite does not heal, but becomes more painful and angry. Suppuration follows, and, unless very active measures are taken, constitutional symptoms come on and often terminate fatally. The poison, it must be understood, is not naturally peculiar to the insect itself, but is derived from the remains of some animal which has died of a kind of cattle-plague, and upon whose flesh or blood the fly had been feeding. To bury such cattle is no safeguard. Pasteur shows that the earth-worms work up the infectious matter to the surface of the ground, and when it has once arrived there it is distributed by flies. This inoculation with carbuncle is more common in France than with us, and the insects which effect it are familiarly spoken of as *mouches charbonneuses*, carbuncle flies. The French have brought this evil upon themselves by destroying the small insectivorous birds.

It is recommended that carrion of all sorts should not be buried, but consigned to tanks of sulphuric acid. Here the infectious matter will be infallibly destroyed, and the product will be useful as manure. It is scarcely necessary to say that animal refuse occurring on a small scale should be consumed with fire, and that no cesspools, dung-hills, etc., should be left without such a dose of disinfectants as may render them unfit for the multiplication of flies. Stagnant pools, even the smallest, should be drained. We may protect our persons against most offensive insects by washing with a good carbolic soap.

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## EXTRACTION OF LIME FROM HIDES.

A most important improvement in tanning has recently been effected by Mr. E. Planta Nesbit, of South Australia, and has been successfully proved in Bermondsey. It is, of course, well known that the first step in tanning is to treat the hides with caustic lime and water, for the purpose of loosening the hairs—a process which requires, sometimes, weeks. The hairs and the fleshy matter are then removed by scraping. The next point is to get rid of the lime, which not only injures the quality of the leather produced, but wastes the tanning material by decomposing the tannin. For this purpose a variety of methods have come into use, none of them thoroughly efficient. Some kinds of hides, after having been well rinsed, are put into weak or spent tan-liquors, and occasionally moved about. They are then transferred to a stronger tan-liquor, and the same process is repeated. But though this operation goes on for weeks or even months, all the lime is never entirely removed. As a recent authority says, "it hinders the ready penetration of the tan-liquor and the perfect combination of tannin with the skins, and so obstinately resists removal, that a portion is always found in the best leather."

In other classes of hides a most disgusting treatment is adopted for the same purpose—the application of *bate* or *pure*. This consists of the dung of dogs, fowls, pigeons, and sometimes even of human excrement. In this loathsome compound the skins are steeped for ten or fifteen minutes, and in some manner, the theory of which is not fully understood, a portion of the lime is removed. Sometimes, however, the whole mass, hides and all, becomes putrid and is hopelessly ruined. We learn that a firm of tanners in Australia lost in this manner £250 worth of hides in a single night.

It is here that Mr. Nesbit's patent process comes in and effects, in a couple of hours, the complete removal of the lime without loss, injury, or nuisance. The theory of the invention is as beautifully simple as the practice is satisfactory. Carbonic acid gas, if applied in sufficient excess, renders lime perfectly soluble in water. Whether it exists in the state of slacked lime (calcium hydroxide), or of chalk (calcium carbonate), the result is the same. The hides, of whatever kind, are placed, as soon as they have been scraped, in a vat of water, and carbonic acid gas is forced in for about an hour. In this short time the lime is so completely removed that neither the careful examination of practical men, nor the refined methods of chemical analysis, can detect a particle.

Along with the lime there is removed a quantity of grease, etc., which the workmen style "muck," and the hides and skins are left clean and supple.

Among the advantages secured are a great improvement in colour, grain (saving one-third material and labour), great economy of time, no breaking or cracking, and a velvet-like texture. The cost of carbonic acid gas is merely nominal. An important collateral benefit is that a tan-yard will cease to be a nuisance.

The importance of this invention will be understood if we remember that tanning in value ranks fourth among our national industries.

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Ink to Write on Glass.—An ink that will write on glass is made from ammonium fluoride dissolved in water, and mixed with three times its weight of barium sulphate.

The Twenty-four Hour System.—This system of measuring time has been adopted on all the lines controlled by the Canadian Pacific Railway Company.

Strength of Snails.—It has been found that a snail weighing one-quarter of an ounce can drag up vertically a load of two ounces and a quarter. Another snail one-third of an ounce in weight carried horizontally a weight of seventeen ounces.

## SOFTENING WATER.

WE are all familiar with the disagreeable effect of washing in "hard" water, and we know that such water is bad for making tea with. We know also that rain-water is soft, and that the hardness of water is due to the presence of salts in solution which have been taken up during the passage of the water through various strata of the earth.

The salts which produce this hardness are usually the carbonates and sulphates of calcium and magnesium. Chemists, however, divide the hardness into *temporary* and *permanent*, and in the purification of water it is most important that both should be taken into account. The temporary hardness relates to the carbonates which are held in solution by the carbonic acid in the water, and can be removed either by the addition of milk of lime, with which the carbonic acid then combines, or by boiling the water, when the carbonic acid is driven off and the carbonates which were in solution are precipitated. The permanent hardness is caused by the sulphates which remain after the carbonates have been removed, and these require special treatment. The total hardness of water is expressed in degrees, based on the number of parts of calcium carbonate, or of the corresponding magnesium or other calcium salts, which are contained in 70,000 parts of the water. The Thames water, for instance, has a total hardness of 15°, or contains in solution 15 grains of carbonate of lime

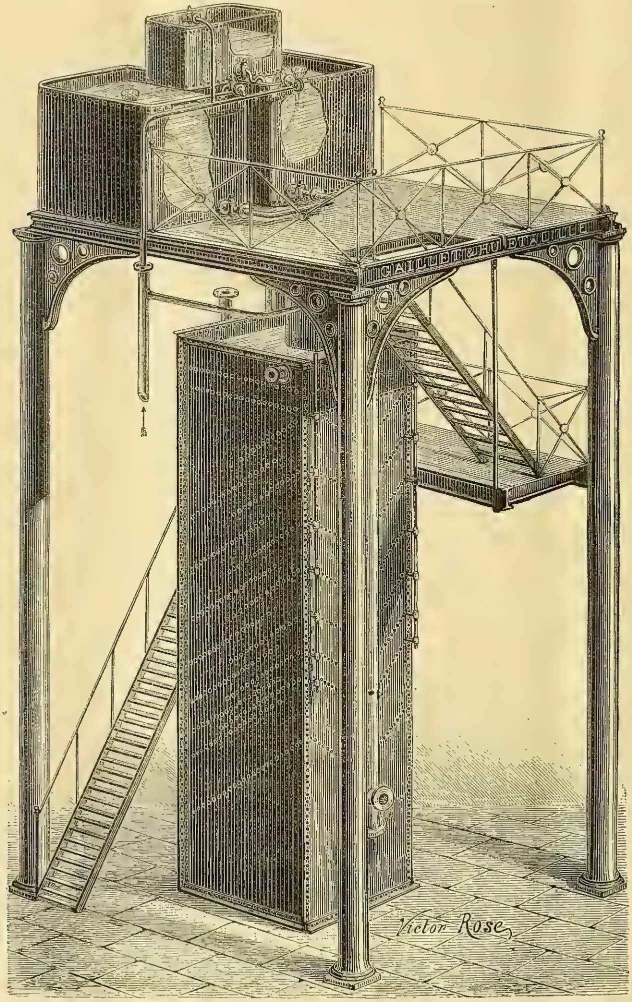


Fig. 1. The Stanhope Water Softener.

per gallon; but, on the other hand, the water of Bala Lake contains only 1·3 grains per gallon.

We have seen that when milk of lime is added to water containing carbonates, held in solution by the presence of carbonic acid, the latter combines with the lime and all the carbonates are removed by precipitation. Following on this principle, Dr. Clark advocated the softening of water on a large scale by adding milk of lime to it, and this process has been largely adopted. It was doubtless a step in the right direction, but it dealt only with the temporary and not with the permanent hardness of the water, and was therefore incomplete. Several attempts have been made to meet this difficulty, and the best apparatus we know of for the purpose is that made by the Stanhope Company, and illustrated below. In this system soda is added in calculated quantities to the lime-water before it is mixed with the water to be softened. The effect of this is to convert the sulphates into carbonates, and these are precipitated in the same way as the original carbonates present in the water. Originally the mixture of hard water and lime-water was run into large reservoirs, in which the precipitated lime gradually sank to the bottom, the clear water at the top being drawn off from time to time. These reservoirs, however, needed a large space and a considerable outlay, so that filters were tried in order to collect the precipitates quickly, but, although the first cost was then reduced, the working cost was much increased owing to the expense of cleaning the filters and of renewing the filtering media.

In the apparatus illustrated, the chemical re-agents are mixed in the small iron tanks placed above the clarifying vessels. These tanks and vessels are in duplicate, so that one set may be prepared for work while the other is in use, and in this way the process is not interrupted.

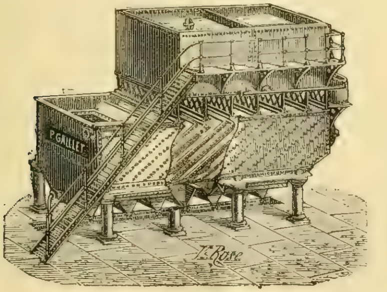

Fig. 2.

The water to be softened enters the large external vertical pipe shown in Fig. 1, a proper proportion of the liquid containing the re-agents being admitted at the same time. The mixture in the pipe then enters the bottom of the clarifying vessel which consists of a large rectangular iron casing, open at the top, and contains V shaped trays inclined at an angle of 45°, as indicated by dotted lines in Fig. 1. The water then rises slowly, the precipitates are deposited on the trays, and when the water reaches the top of the vessel it is quite clear and fit for use. With a reasonable amount of care, clogging of the apparatus is almost impossible, and it is very easy to manage. The average cost of the chemicals required is said to be one penny per 1,000 gallons. The apparatus shown in Fig. 2 works on the same principle, but is differently arranged so as to occupy less vertical height.

We all know that when hard water is used, much more soap is required to produce a lather than with soft water. The reason of this is that when the water is hard the salts of lime and magnesia form an insoluble compound with the fatty acid of the soap, which we call curd. This is not only an inconvenience, but is the cause of great waste of soap, which in certain manufacturing processes, such as the washing of wool, for instance, is very considerable. Every degree of hardness destroys in this manner one pound of the best soap for every 1,000 gallons of water, and this is an absolute loss without any compensating advantage whatever. In a mill using 10,000 gallons of water daily, with 10° of hardness, the annual loss in soap (at 2d. per lb.) for 300 working days will therefore be £250; and for a mill using 20,000 gallons daily, with 15° of hardness the annual loss in soap will be £375. Moreover, there is a further disadvantage in using hard water for work of this kind, because the material is more dull in colour and more rough to the touch than it would be if soft water were used. The need of soft water is, in fact, very great, especially with textile manufacturers of all kinds.

To all users of steam and hot water it is also of the greatest importance that the water should not be hard, or deposits will be formed in the boilers and pipes, and this will not only cause serious loss and inconvenience, but may also be a source of danger. It is, in fact, estimated that half the boiler explosions which occur are caused by the scale formed by the precipitates from the water. This scale prevents the water from being in contact with the boiler-plates over the fire. The latter become over-heated, there is a sudden generation of steam, and the boiler is unduly strained or burst. We could point out many other disadvantages of hard water, but we have said enough to indicate the importance of the subject, and to point to the benefit of using an efficient softening apparatus when natural soft water cannot be obtained.

## THE SOURCE OF MUSCULAR POWER.

In his presidential address at the recent meeting of the British Association, Sir Henry Roscoe briefly referred to this very important subject, and although his statements were clearly expressed, and were familiar to physiologists, we fear they were too condensed to be fully appreciated by the lay members of his audience. The subject is, however, one of the greatest importance to all, and as Dr. Frankland observes, it is the corner-stone of the physiological edifice, and the key to the nutrition of animals. We make no apology, therefore, for dwelling on such a subject, and for endeavouring to explain the present state of our knowledge.

Sir Henry Roscoe reminded us that nearly fifty years ago Liebig presented to the Chemical Section of the British Association a communication in which, for the first time, an attempt was made to explain the phenomena of life on chemical and physical lines. In this paper he admitted the applicability of the great principle of the conservation of energy to the functions of animals, and pointed out that the animal cannot generate more heat than is produced by the combustion of the carbon and hydrogen of his food.

"The source of animal heat," says Liebig, "has previously been ascribed to nervous action, or to the contraction of the muscles, or even to the mechanical motions of the body, as if these motions could exist without an expenditure of force consumed in producing them." According to Sir Henry Roscoe, Liebig compared the living body to a laboratory furnace, in which a complicated series of changes occur in the fuel, but in which the end-products are carbonic acid and water, the amount of heat evolved being dependent, not upon the intermediate, but upon the final products.

Liebig asked himself the question, Does every kind of food go to the production of heat; or can we distinguish, on the one hand, between the kind of food which goes to create warmth, and, on the other, that by the oxidation of which the motions and mechanical energy of the body are kept up? He thought he was able to do this, and he divided food into two categories; the starchy and fatty food is that, said he, which by its combustion provides the warmth necessary for the existence and life of the body. The albuminous or nitrogenous constituents of our food, the flesh meat, the gluten, the casein out of which our muscles are built up, are not available for the purposes of creating warmth, but it is by the *waste of those muscles* that the mechanical energy, the activity, the motions of the animal are supplied. We see, said Liebig, that the Esquimaux feeds on fat and tallow, and this burning in his body keeps out the cold. The Gaucho, riding on the pampas, lives entirely on dried meat, and the rowing man and pugilist, trained on beef steaks and porter, require little food to keep up the temperature of their bodies, but much to enable them to meet the demand for fresh muscular tissue, and for this purpose they need to live on a strongly nitrogenous diet.

This was the teaching of so able a chemist and physiologist as Liebig, but modern science has proved that his hypothesis was a wrong one, and we now have good reason for supposing that no such distinction as he laid down can hold good. Muscle is a nitrogenous substance, and if it were oxidised as Liebig supposed, it would yield a nitrogenous excretion representing the oxidised nitrogenous substance. All the nitrogen which is excreted from the body is recognised chemically as urea, uric acid, etc., and if Liebig were correct, the work done by the body should be represented by the amount of these nitrogenous compounds excreted. This, however, is not the case, for the urea, etc., is not increased in amount in proportion to the work, as was proved by the well-known Faulhorn experiments of Messrs. Fick and Wiscelenus. They, in fact, proved that the actual energy represented by the mechanical work of raising the body to the summit of this mountain was twice as great as that which could possibly be produced by the oxidation of the nitrogenous constituents eliminated from the body during twenty-four hours. That is to say, taking the amount of nitrogenous substance cast off from the body, not only whilst the work was being done but during twenty-four hours, the mechanical effect capable of being produced by the combustion of muscular tissue, from which this cast-off material was derived, would only have raised the body half way up the Faulhorn.

On the other hand the excretion of carbonic acid and water has been proved to be in proportion to the amount of muscular exertion, and as the heat value of the carbon and hydrogen it represents is easily determined, and Dr. Joule has taught us how to obtain the mechanical equivalent of heat, we are able to measure the work done by the oxidation of these constituents of the body in foot pounds. In a series of experiments made by Dr. Frankland, he was able to determine the quantity of energy or force manifested as heat during the oxidation of a given weight of alimentary substance, and in this way he was able to estimate the comparative value of different food substances equivalent to the muscular force which would raise a man of ten-stone weight 10,000 feet, this being the estimated daily expenditure of force in working the machinery of the body.

Reverting to Liebig's hypothesis, we can now see that it is not substantiated, and that although the nitrogenous constituents of the food do doubtless go to repair the waste of muscle, which, like every other living tissue, wears out and needs renewal, the non-nitrogenous food not only supplies animal heat, but also furnishes by its oxidation the muscular energy of the body. The solid hydrocarbons, starch and oil, after digestion and incorporation with the tissues, on being converted into carbonic acid and water, supply the heat energy of the body, just as the carbon and hydrocarbon in coal supplies heat energy to a steam engine. The nitrogenous constituents, however, are used, as we observed above, to make good the wear and tear of the nitrogenous tissues; and it must be remembered that the muscles wear out faster when doing work, and that the amount of nitrogenous food must therefore bear due proportion to the amount of work performed.

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## THE TELEPHONE: ITS PRINCIPLES, CONSTRUCTION, & APPLICATION.—III.

We must return to the subject of variable resistance transmitters, and see how the principle involved is practically applied at present. Edison brought out a transmitter in which the contact of variable resistance is between a platinum plate and a little button of compressed lampblack. It is illustrated in Fig. 9.*

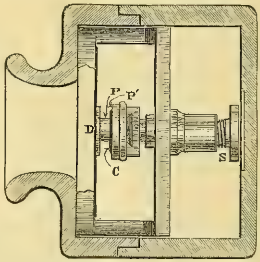



Fig. 9. EDISON'S TRANSMITTER.

The case is of ebonite, containing the diaphragm D, carrying on it a cork pad attached to the platinum disc P, between which and a similar disc P′ is the little button of carbon, C. The screw, S, adjusts the pressure on the contacts between C and PP′, and the elasticity of the cork and the carbon button are sufficient to prevent any break in the contact, and yet to allow the variations of pressure to be transmitted to the contacts. Part of the effect of this transmitter is probably due to a lessening of the resistance of the carbon button itself upon compression, and Edison himself claims this as the principal action. This theory is, however, hardly borne out by later experiments.

Edison suggested the use of a button of silk or similar elastic fibre impregnated with powdered graphite (blacklead), but no instrument with such a material is in practical use, and there are comparatively few Edison transmitters now employed. This is not because the Edison transmitter is not a good one, but because the soft carbon button is very fragile, and the hard carbon transmitters about to be described are more easily kept in adjustment and repair.

The two forms of carbon transmitter chiefly employed in the United Kingdom are the Gower-Bell and the Blake instruments. The former is used by the Postal Telegraph department. The latter is the instrument adopted by the United Telephone Company and its offspring.

The Gower-Bell is what is known as a microphone

* We are indebted to Messrs. Longmans, Green and Co. for the illustrations of Figs. 9, 10, and 11, and to the Secretary of the Society of Telegraph Engineers and Electricians for Fig. 12.

transmitter, so-called from the fact that very small sounds can be rendered audible by the use of a microphone and telephone. The tread of a fly, for example, can be distinctly heard if the insect is confined in a box placed on a sounding-board or diaphragm to which the microphone is attached. Professor Hughes invented the microphone in its present form, though it is dependent on the principle involved in Reis's transmitters. The Gower-Bell form of microphone is shown in Figure 10, where SS′ are two thin copper strips, and CC are nine blocks, either of retort carbon or the carbon

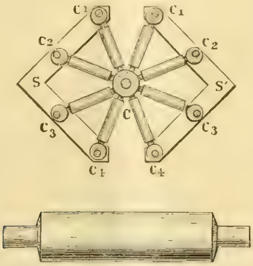



Fig. 10. The Gower-Bell Microphone.

rods used for electric lighting. The central block has eight holes drilled in it, one opposite each of the outer blocks, each of which has a similar hole drilled in it. Eight pieces of carbon rods have their ends turned down as shown in the figure, and these turned-down ends rest loosely in the holes in the blocks. The current passes from one copper strip to the other, through the carbons, blocks, and rods, and has to go through sixteen loose contacts on its way, the loose contacts being, as an electrician would say, four in series and four in parallel, that is to say, the whole current has four roads to split between, and each fraction of the current passes through four loose contacts in succession.

In this way the effect of the vibrations on the strength of the current is multiplied.

Fig. 11 is a section of the "Blake" transmitter. This is

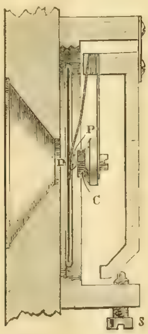



Fig. 11. The Blake Transmitter.

probably the most widely used form of transmitter, and bears a very strong resemblance to Reis's instruments. D is the diaphragm, P a little platinum button on the end of a very delicate spring, and C a hard carbon block attached to a fairly stiff spring. The current passes between the platinum and the carbon. The two springs are carried by a cast-iron bridge or bar, which is itself supported by a stiff spring at the same end, and has at the other extremity a screw S banking against its inclined end. By turning this screw the pressure between the contact points can be adjusted, and any desired degree of sensitiveness obtained. This is an extremely good form of transmitter, though not so sensitive as the microphone forms. It transmits with very clear articulation, and can be adjusted, within limits of course, for voices of varying loudness and pitch. Generally speaking, a lighter pressure is best for high-pitched voices, such as those of women and children; a heavier pressure is necessary if the instrument is to be used by men, whose strong deep tones tend to set the springs into too great vibration, causing complete interruptions of the current, and producing an unintelligible growl or a succession of sharp cracks in the distant receiver.

There are other forms of variable resistance transmitters in use, notably Ader's, a microphone-form much in use on the Continent, and Professor Silvanus Thompson's valve telephone, which is a very peculiar form, consisting of a tiny metallic or carbon ball standing on three little legs, at the upper end of a tube leading from the mouthpiece, and turning up by a gentle curve. The action is produced by the air waves—somewhat concentrated, no doubt, by the shape of the mouthpiece—passing up the tube and beating on the lower surface of the ball, varying the pressure

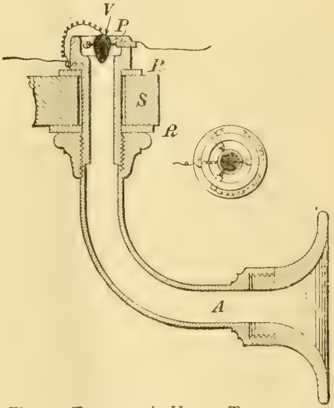



Fig. 12. Thompson's Valve Telephone.

between it and its supports, and so varying the electrical resistance between them. This transmitter speaks very well, and it is unique among modern instruments in following Reis's example, and sometimes using metallic surfaces. Professor Thompson has, however, found some difficulty in getting a metal free from the practical drawbacks mentioned in describing Reis's instrument, and now uses carbon contacts. He claims to have made a good working transmitter, and it has already met with a certain amount of commercial success. One form is illustrated in Fig. 12, where A is the tube provided with a flaring mouthpiece, V the valve, egg-shaped in this instrument, and P the supports. The valve and supports are shown in plan to the right of the general section. This is practically a microphone with three contacts, but the current passes from centre to circumference, or vice-versa; the coiled wire connection to the valve can be seen attached to its upper end. For further information on microphonic transmitters, and some of the theories put forward in connection with them, Professor Thompson's paper on Telephonic Investigations, published in No. 65 of the *Journal of the Society of Telegraph Engineers*, should be consulted. The succeeding discussion will be found more amusing than is commonly the case.

Although the use of a variable resistance transmitter is a great improvement over the Bell transmitter on short lines, very little benefit results from its employment on lines more than a mile or two long, and beyond a certain length the Bell performs at least as well. The reason is that the variation of the current is proportional to the amount of variation in the total resistance of the circuit, including the battery, the transmitter itself, the line, and the receiving instrument. The resistance of most transmitters lies between 2 and 30 ohms or units, and the total variation due to the air vibrations is not more than 25 per cent. of this. As the resistance of a mile of the wire usually employed for telephonic purposes is from 15 to 20 ohms, the resistance of the receiver from 50 to 70 ohms, and the battery 6 to 10 ohms, it will appear that on a line only a few miles long the ripples set up in the constantly flowing current by the variations of the transmitter resistance are very small. Little is gained by using a more powerful battery, as the increased minimum current holds the receiving diaphragm with greater force, and so renders it less sensitive.

The use of an induction-coil was very soon suggested as a means of increasing the transmitter's utility, and it is now all but universally used. Who invented this application is not quite clear. Possibly the idea occurred to more than one man almost simultaneously. At any rate, the inventor deserves the thanks of his contemporaries, for he made the world a present of the invention, as Professor Hughes did of his invention of the microphone.

In describing the Bell telephone, it was stated that a change in the magnetic conditions surrounding a wire might produce a current in that wire, and also that a wire carrying a current produced a magnetic effect in its neighbourhood, magnetising iron, deflecting a magnetic needle, or attracting iron filings. One result of these two effects is that, if two wires run parallel to each other, a change in the strength of a current carried by one produces a tendency to a current in the other; if the second wire forms part of a closed circuit, a current actually flows. This current is called a secondary, or induced current. It continues as long as the first, or primary, current is changing in strength. Its strength is proportional to the rapidity of change of the primary (we might put this in the language of the differential calculus, but it would not be any truer) to the length ol the parallel parts of the two wires, and to the relative distance form, and environment of the wires. The nearer together they are, or the more easily magnetised the surrounding bodies are, the greater will be the inductive effect of the primary circuit. So long, however, as the primary current is steady, no secondary current will be produced. It is found that the best form for telephonic induction-coils is a simple bobbin of some insulating material, such as wood or ebonite, with a core of iron wires running through its centre, and with the two wires wound on it in succession. The primary wire is usually wound on first, and is a comparatively short, thick wire; the secondary wire is wound over the primary, and is very much finer and longer. The primary is thus of low resistance, and a great length of secondary wire is arranged parallel to a small length of primary wire. The effect of the iron core is to increase the magnetic effect of the primary current variations, and so to increase the inducting power. That it has this effect proves that the inductive action is not directly electrical, but that a magnetic effect intervenes. A little induction-coil can be easily made by taking an ordinary empty cotton-reel, filling the central hole with a bundle of fine iron-wire, and winding into the space formerly occupied by the thread first a length of say No. 20 B.W.G. silk-covered copper wire, and then a length of No. 36 or 40 silk-covered wire. This will be better if a boxwood or ebonite bobbin is employed, with the central tube very thin and the copper wire well served with paraffin wax. If, then, an ordinary galvanic-battery cell is put in circuit with the thick wire, a galvanometer connected to the ends of the fine wire will show a deflection each time the primary circuit is made or broken. A small shock can be felt at those moments, and other proofs of the secondary current obtained.

Now if the primary wire of such a coil is put in circuit with a battery and a variable resistance transmitter, the transmitter will probably be by far the highest resistance of the circuit, and its resistance variations will cause a fairly large percentage variation in the current. As increases and decreases in the primary current cause currents of opposite direction in the secondary circuit, the result of the current variations in the primary circuit will be to cause alternating currents to flow in the secondary circuit, corresponding, of course, to the motions of the transmitter's diaphragm, and capable of imparting similar motions to the diaphragm of the receiving instrument. The advantages obtained are that by suitable winding of the induction coil and increase of the battery power, the induced currents can be made comparatively powerful, and, as there is no permanent current flowing through the receiving instrument, its sensitiveness is not interfered with by the attraction of the magnet for the armature. This combination of variable resistance transmitter, battery, induction coil, and Bell or similar receiver, is, therefore, the best yet made, and is indeed the only one of practical use for any lines of respectable length.

In the next article, some of the most useful practical arrangements, including the exchange system, will be described. We may conclude by putting down in tabular form again the cycle of action in a telephone circuit with a variable resistance transmitter, and a battery as the sending arrangement, and also with an induction coil added :—

*Mechanical Operations :—*

Air vibrations (or changes of pressure) } converted into vibrations of transmitter diaphragm—

And variations of pressure on transmitter contacts—

Causing—

Variations of electrical—

*Electrical :—*

Resistance of transmitter contacts, and consequent variations of current—operations—

Strength—resulting in—variable magnetisation of receiver magnet and—

*Mechanical :—*

Vibrations of receiver diaphragm—converted into air vibrations.

The introduction of the induction coil adds the following steps, between the current variation and the magnetic effect in the receiver :—

Variations of current strength in primary circuit—inducing—

Alternating currents in secondary circuit—resulting in—

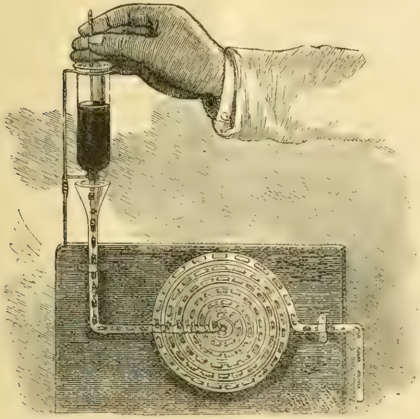
Variable magnetisation of receiver magnet.

It will be noticed that there is no direct transfer of energy from the transmitting to the receiving diaphragm; the battery gives out the energy utilised in the receiver; the transmitter merely controls the amount given out. There is thus no direct relation between the two amounts of energy, and more work may be done in the secondary circuit than is given by the vibrating air to the transmitting diaphragm. Hence it is that an actual magnifying of sound may be obtained by suitable arrangements, and that a musical performance, at a distance of many miles, may be rendered audible to a roomful of people.

*(To be continued.)*

## NOVEL LANTERN SLIDE.

THE engraving shows an inexpensive and very simple and effective device for exhibiting the action of the circulating fountain upon a screen. It consists of a glass tube of small diameter bent into the form of a volute, with the inner end of the tube extended laterally, and then bent vertically, a funnel being provided at the upper extremity. The table at the outer end of the spiral is bent outward radially, then downward at right angles. The tube thus bent is mounted on a board having a circular aperture a little larger than the spiral, so that the entire spiral may be strongly illuminated, while the ends of the tube leading to and from the spiral are concealed by the board. Above the funnel there is a reservoir with a small opening at the bottom, and through this a pointed wooden rod extends down-



wards into the tube below, and forms a valve for regulating the flow of liquid. The liquid employed is water, to which has been added some colouring matter, such as aniline blue, red, or green. A few drops of aniline red ink answers for this purpose. The flow of the liquid is started by loosening the valve, so that the water drops regularly into the funnel of the tube below. The drops should fall intermittently, so as to include air spaces between them. The liquid, as it issues from the downwardly turned end of the spiral, is received in a cup, by which it may be returned to the reservoir, and so used again. When it is desired to accelerate the motion of the liquid in the tube, a short rubber tube is connected with the end of the glass tube which is bent downwards. The glass tube should be about one-sixteenth of an inch internal diameter, and the spiral about three and a half inches in diameter. When the fountain is in operation, the spiral seems to revolve, but each convolution appears to turn at a different rate of speed, owing to its increasing diameter. When projected with a good lantern and a strong light, it becomes a very interesting object.—*Scientific American.*

## CLINICAL THERMOMETER.

AT the Inventions Exhibition, Mr. Immisch showed a very compact and ingenious clinical thermometer which attracted much attention. Since then he has further improved it, and has made it suitable for veterinary as well as other purposes. Fig. 1 is a full-sized view of the thermometer, which is only one inch in diameter, and has the appearance of a locket. Its action depends on the movement of a spiral metal tube which is filled with a liquid which expands and contracts with variations of temperature. The movement of the tube is transmitted to the pointer by a simple me-

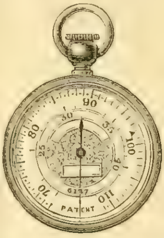


Fig. 1. CLINICAL THERMOMETER (full size).

chanical device, and as the spiral tube can move without appreciable resistance it accurately records the changes of temperature it is subjected to. There is a further advantage due to the fact that the tube is always full of liquid, so that the pointer is not affected by changes of atmospheric

Fig. 2. THERMOMETER WITH FLEXIBLE HANDLE FOR VETERINARY PURPOSES.

pressure. The thermometer is now fitted with a stop arrangement, so that the pointer can be fixed when required, and there cannot be uncertainty as to the reading of the temperature taken. It is stated that the authorities at Kew have satisfied themselves as to the permanency and reliability of these instruments, and that they omit as unnecessary the usual caution they give with glass thermometers as to their liability to change with time. Fig. 2 shows an instrument provided with a flexible handle which can be attached, when required, for veterinary purposes.

## THE SIZE OF THE SUN AND MOON.

IT is strange that few people can indicate the height of so well-known an object as a "chimney pot" hat, by a mark on the wall, without making an error of from one-third to one-half in excess. This is nothing compared with the diversity of opinion as to the apparent size of the sun or moon. Few persons who have not some acquaintance with scientific measurements understand that to say the moon looks "as big as a plate," expresses nothing, though it at once becomes an intelligible estimate when the distance at which the plate is supposed to be, is given also.

Enquiries from a dozen people will elicit guesses varying from "the size of a threepenny bit" to "a cartwheel," but on being asked further, at what distance from the eye these objects are supposed to be, the replies will be given with some hesitation.

It might be imagined that the distance, which is almost invariably omitted at first, would be the distance at which one would most often see the object, such as a threepenny-bit at arm's length, a plate at two or three yards, and a cartwheel at perhaps forty to fifty yards, but this is not so.

A circle 0·22-inch in diameter, fairly represented by O, at two feet distance, would just hide the moon, supposing the pupil of the eye were a point. The coin would have to be seventy inches away, and a ring of light would be seen round a four-foot wheel were it more than 530 feet distant. Sir John Herschel informs us that many persons spoke of the tail of the great comet of 1858 as being several yards long, without at all seeming aware of the absurdity of such an expression.

Among the ancient Greek philosophers, Anaxagoras was laughed at for saying that the sun might be as large as all Greece, while another sage put himself beyond criticism by maintaining that it was "precisely as large as it looks to be." The latter idea may be more than a mere truism, and might have meant that, in the absence of any information as to the distance, the only measurement was one of apparent, or angular magnitude. The measurements of astronomers are always given in the first instance as angles. The oldest method of expressing an angle was to state how many times it was contained in a right angle. Archimedes attempted to measure the apparent diameter of the sun by means of a cylinder standing upright on a level beam. He observed it at sunrise, when it could be looked at without injuring his eyes, and he noted how far the cylinder was from his eye when it just hid the sun. He made another experiment to find the correction for the size of the pupil of his eye, which, having an appreciable size, could, as it were, see round the sides of the cylinder. He then measured the length of the bar, and the diameter of the cylinder, and expressed the angle in the number of times it was contained in a right angle. It is hardly credible that he had not sufficient knowledge of trigonometry to calculate the angle of the triangle of which he knew the base and the length of two equal sides.

We measure angles in degrees, of which there are 360 in a complete circle, and 90 in a right angle. Each degree is divided into 60 minutes, and each minute into 60 seconds. The signs °, ′, and ″, are used for degrees, minutes, and seconds respectively.

The apparent size of the moon varies for two reasons. In the first place, it does not revolve round the earth in a circle, but in an ellipse, the earth being at one focus. The length of the ellipse is to its width as 1 is to ·05485. When the moon is nearest to the earth it is said to be in perigee, and when it is at the farthest it is in apogee. Its apparent diameter under these circumstances varies from 33′ 30″ to 29′ 20″, the observer being supposed to be at the centre of the earth. The surface of the earth immediately under the moon is evidently nearer, by half the diameter of the globe. The distance of the moon from the centre of the earth is about thirty diameters of the latter, and therefore the moon will appear about one-sixtieth larger when it is over head than when it is on the horizon.

It is, however, well known that the sun or moon near the horizon appear to be considerably larger than when high in the sky, and much ingenuity and not a little bad science has been brought to bear upon the question. Gassendius, who ought to have known better, thought that as the moon was less bright when near the horizon, the pupil of the eye would be more dilated than when the brilliancy was greater, and therefore it appeared larger; this opinion was supported by a French Abbé, who supposed that the opening of the iris made the crystalline lens flatter. This is on a par with the idea that as the eyes of horses magnify more than those of most other animals, their stepping so high is thus accounted for, since each stone must appear to be a serious obstacle; this is also given as a reason for their timidity. It is hardly necessary to explain that in both cases, all the surrounding objects would also be magnified, and the relative sizes, by which we judge absolute sizes, would remain the same.

Another explanation is, that the effect is produced by refraction; in fact, at a well-known school, Cowper's "Winter Evening" was being discussed, and at the line describing the rising moon,

"Resplendent less, but of an ampler round,"

the question went round the class, "Why should it appear larger when near the horizon?" when the present writer, who, it may be inferred, was not at the head of the form, feeling that it was more politic to give the answer which in all probability was in the master's mind, than to attempt to expound the theory which he believed to be the more correct, replied, "the refraction of the damp air," which sent him unjustly joyful to the top.

Descartes was the first to give a reasonable explanation, and if it is not generally considered to be correct, it suggests a still simpler solution. He said that we are accustomed to judge of the size of objects by mentally comparing their apparent magnitude with their apparent distance, and that when the sun or moon is low we are reminded, by comparing it with surrounding objects, that it is very far off; but when it is high in the sky we have nothing in its neighbourhood with which to compare it, and it therefore appears nearer, and consequently smaller. But does the moon appear more distant when it is high? Does it not rather, when rising, appear as though it were at the horizon; and when it is high does it not appear to be among the stars, at a distance which the mind makes no attempt to grasp?

The true solution appears to be that when it is near the horizon we can readily compare the moon with trees and houses, which look small beside it. A tree fifty-five feet high, five miles off, would appear to be about equal to one quarter of the vertical diameter of the moon when it had just risen. But when it is high we can only compare it with the upper boughs of trees, or with chimney-pots, one of which would completely hide it; then it is dwarfed by its surroundings, instead of the reverse. It is easy to prove that it is the effect of its surroundings which alters the apparent size by simply looking at it through a roll of paper, or even through a loosely-closed fist.

The refraction of the air not only does not magnify, but has the opposite effect. The sun setting at sea, or behind a very distant horizon, loses its circular outline, and becomes irregularly elliptical. The vertical diameter is shortened, while the horizontal remains the same. It was probably not until the effect of refraction had been carefully studied and reduced to a definite rule that it was known that at the moment we see the lower edge of the sun touch the horizon the sun has really *already set*, and that it is merely on account of refraction that we still see it. The effect of refraction of the air is to make the sun, moon, or stars higher in the sky than they really are. The effect is much greater near the horizon than at higher angles. Assuming the sun to have an apparent diameter of 32′ when the lower edge, or limb, as it is called by astronomers, appears to touch the horizon, the refraction at that limb is 33′, the upper limb is 32′ above the horizon, and at this point the refraction is only 28′ 6″; there is therefore a difference of 4′ 54″, which is the difference between the vertical and horizontal diameters.

There is a very prevalent idea that mist or fog has a magnifying power. Not only has the presence of moisture very little to do with refraction, which depends on the temperature and pressure of the atmosphere, but on no optical principles can it be shown how a mist or fog could produce a magnifying of an object. We must therefore fall back on the effect of the surroundings, and here Descartes' theory probably solves this problem better than the one to which reference has been made. When travellers who have lost their way, peering anxiously into the blankness of a mist, catch the first glimpse of an object, they are inclined to suppose that because it has only just come into view, it is a great way off, and are sometimes startled by its colossal appearance.

As another example of the difficulty of forming an accurate estimate of the apparent size of an object, it is found that most people imagine that an opera-glass which only magnifies some two or three times does not magnify at all, but merely makes the image clearer. The magnifying power can easily be appreciated by holding the glass to one eye only, keeping both eyes open; the apparent size of the object seen by direct vision and by the glass can then be compared.

It is to be observed that these errors all relate to the estimation of absolute size, based upon the apparent or angular magnitude of the thing observed, and a conscious or unconscious estimate of its distance from the observer. The judgment of relative size can be made much more accurately. Among the interesting measurements made at the various anthropometric laboratories which have been arranged by Mr. Francis Galton is that of the judgment of the eye in dividing a line of fifteen inches into three parts and into two parts, and in setting a hinged rod square with a fixed rod. Such estimates are of course made with greater facility and accuracy by those engaged in occupations of a more or less structural or mechanical nature, but the errors of decidedly unskilful persons in the judgment of such relative magnitudes are of an entirely different order, and far less serious than those of many scientific observers in questions of mere apparent size.

It may be well, in conclusion, to give the actual dimensions of the sun and moon, and their distances. The moon is about 2,159 miles in diameter, and its distance from the earth's centre varies from 252,948 to 221,593 miles. Its diameter is to its mean distance nearly as 9 is to 1,000. The diameter of the sun is 852,000 miles, and its distance varies from 92,963,000 miles in summer, to 89,897,000 in winter. The proportions between the diameters and the distances are so close in the two cases that the apparent diameters are nearly the same. The sun only varies by about one minute, while the moon varies about four minutes. The mean apparent diameter of the sun is nearly one minute greater than that of the moon. If a total eclipse occurs when the moon happens to be of greater apparent diameter than the sun, the latter is completely hidden, but if otherwise, the eclipse is said to be annular, because an annulus or ring of light is to be seen round the moon.

In the recent total eclipse the disc of the moon was considerably greater than that of the sun, and it was hoped that observations taken at northern stations, where the sun was only just hidden at one edge, compared with those at southern stations where the opposite edge or limb was just eclipsed, would have thrown some further light on the measurement of their apparent diameters; the necessary observation being the duration of the totality. Unfortunately cloudy weather prevailed so generally, that it is probable that no such calculations will be possible.

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## CORROSION OF METALS.

MUCH trouble is often experienced in mines and other underground works owing to the rapid corrosion of the iron and steel used in the machinery. This corrosion is chiefly due to the acid character of the water in the mines, and in some places it is very difficult to contend with. Brass and gun-metal resist the corrosive action to a great extent, but they are not sufficiently durable. Of late an alloy called "Delta metal," which is a brass as hard and durable as mild steel, has been much used for various kinds of machinery and fittings, and recently an interesting trial has been made to test its power of resisting corrosion in the

WROUGHT IRON. STEEL. DELTA METAL.

acid waters of a mine. Equal-sized bars of wrought iron, steel, and Delta metal were carefully weighed and then left six and a half months in the mine water, and at the end of that time they were taken out and reweighed. The wrought iron had lost 46·3 per cent., the steel 45·4 per cent., and the Delta metal only 1·2 per cent. of its original weight. The bars were photographed on being taken out of the water, and from the accompanying illustrations it will be seen at a glance that there is a very marked difference in the effects produced on the three metals.

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HOW TO COPY PRINTED MATTER.—Printed matter may be copied on any paper of an absorbent nature by dampening the surface with a weak solution of acetate of iron and pressing in an ordinary copying press. Old writing may also be copied on unsized paper if wet with a weak solution of sulphate of iron mixed with a simple solution of sugar syrup.

## EVENING TECHNICAL INSTRUCTION IN ENGLAND.—III.*

THE trades in connection with which courses of lessons are subsidised by the Institute are the following:—

1. Alkali and Allied Branches.
   (*a*) Salt manufacture.
   (*b*) Alkali "
   (*c*) Soap "
2. Bread-making.
3. (*a*) Brewing.
   (*b*) Spirit manufacture.
4. Coal-Tar Products.
5. Sugar manufacture.
6. Fuel.
7. Oils, Painters' Colours and Varnishes, manufacture of.
8. Oils and Fats, including Candle-manufacture.
9. Gas manufacture.
10. Iron and Steel manufacture.
11. Paper "
12. Pottery and Porcelain "
13. Glass "
14. Dyeing—
    (*a*) Silk.
    (*b*) Wool.
    (*c*) Cotton and Vegetable fibres.
15. Bleaching and Printing of Calico or Linen.
16. Leather.
    (*a*) Tanning Leather.
    (*b*) Boot and Shoe manufacture.
17. Photography.
18. Electro-Metallurgy.
19. Textile Fabrics—
    (*a*) Cloth manufacture.
    (*b*) Cotton "
    (*c*) Linen "
    (*d*) Silk "
    (*e*) Jute "
20. (*a*) Lace manufacture.
    (*b*) Framework Knitting.
21. Weaving and Pattern-designing.
22. Electrical Engineering—
    (*a*) Telegraphy.
    (*b*) Electric Lighting and Transmission of Power
    (*c*) Electrical Instrument Making.
23. Metal Plate Work.
24. Plumbers' "
25. Silversmiths' "
26. Watch and Clock Making.
27. Tools—
    (*a*) Wood-working.
    (*b*) Metal-working.
28. Mechanical Engineering.
29. Carriage Building.
30. Printing—
    (*a*) Typography.
    (*b*) Lithography, etc.
31. Ores, Raising and Preparation of.
32. Mine Surveying.
33. Milling (Flour manufacture).
34. Carpentry and Joinery.
35. Brickwork and Masonry.

Examinations in these subjects are held simultaneously in the month of May. In some of the subjects the candidates are required to do practical work in addition to answering the questions of the examiners. Thus, in weaving, the candidate is expected to design an original pattern, to transfer the design to special paper, and to weave in suitable material his own pattern. He is also required to answer questions on the structure of looms and other questions connected with the subject of weaving. In carpentry, the candidate is required to execute a piece of work from his own drawings, and to forward the drawings and the work to the Institute for examination. Candidates in printing are practically examined in printing works in different parts of the country, and candidates in plumbing, besides showing by their answers to questions that they understand the principles of sanitation, are required, in the presence of the examiners, to make joints, and to beat sheets of lead to given shapes.

It will be seen that the object of the instruction is to supplement the instruction in mathematics, physics, mechanics, and chemistry which is under the direction of the State. Students are encouraged to present themselves for the examinations of the Institute by the offer of certificates, and by prizes of from £1 to £5, with medals of silver and bronze. Employers of labour commence to accept the certificates of the Institute as certificates of proficiency, and in this way the examinations in technology held by the Institute of Guilds are coming to replace the ceremony of admitting the young apprentice to the freedom of his Guild, which took place, years ago, under the auspices of the master and assistants of the Guild.

The Institute has experienced great difficulty in finding competent teachers for these classes. The teacher of the technology of a trade must understand the sciences that have reference to that trade, and at the same time he must have obtained the experience which can only be acquired in the workshop or the factory. It is this combination which is difficult to find. The demand, however, is bringing forth the supply, and some of the most intelligent of the foremen in large works study the principles of science first at the evening classes in their own towns, and afterwards at the Normal Schools in London, to qualify themselves as teachers.

The number of students in attendance at these classes has greatly increased since the year 1880, when they were established. In that year there were 816 students examined in 24 subjects, and of these 515 obtained certificates. In 1886 classes were held at 192 centres, 7,660 students received instruction, and 4,764 candidates presented themselves for examination, of whom 2,627 obtained certificates.

The system of evening technical instruction in England, both as regards science, art, and technology, is complicated by the fact that it is controlled from a central office situated in London. This arrangement has its advantages and disadvantages. In many cases, the instruction cannot be well adapted to local demands and to the requirements of different trades. The practices of a trade differ in almost every locality, and each school would doubtless prefer to adapt its course of instruction to the requirements of the trade of the district. On the other hand, it is an advantage that the State encourages artisans to learn the elements of science apart from their application to any particular industry. The great value of science to the artisan consists in this: that it enables him to understand the cause of unexpected phenomena, and for this purpose it is necessary that he should know facts in science which would seem to be quite remote from those connected with his ordinary work. Moreover, the examinations conducted by the State and by the Institute furnish a guarantee that the instruction has been satisfactory, and enable a correct comparison to be instituted between

* Continued from page 163.

the results of the instruction in different parts of the country.

Evening instruction in England is not gratuitous. The fees paid by the students, although small, help to defray the expenses of the school. The opinion prevails in England that people value most what they pay for. My own experience leads me to the opinion that evening schools are most frequented when the instruction is quite gratuitous.

There is a growing opinion in England in favour of enabling municipalities, either through the agency of the School Board or through the Town Council, to subsidise evening technical instruction. At present, as I have explained, the schools are supported by the students' fees, by voluntary subscriptions, and by the subventions on the results of the examinations. There are many persons who think the fees ought to be abolished, and that the subscriptions afford too precarious a source of income to permit of the engagement of very good teachers. If the schools received subsidies from the municipalities in addition to the subventions from the State, the fees might be reduced and the teaching might be improved.

A large number of children leave school at so young an age that they are not sufficiently advanced to profit by the courses of science and technology which are held in all large towns of England. To help these there is now a voluntary movement to found what are called "Recreative classes." The object of this movement is to attract children to courses of instruction in drawing and in elementary subjects, by amusements of different sorts, such as concerts, popular lectures, description of travel illustrated by lantern-slides, etc. We have not in England anything which corresponds exactly with the Fortbildungsschulen and Ergänzungsschulen of Germany, and these courses are intended to take their place, and to serve as an introduction to the more advanced technical courses under the Department and the Institute.

As a factor in the industrial prosperity of a nation nothing is more important than the technical education of its workmen. It is impossible that the mass of children who are to become ordinary workmen should remain long enough at school to obtain a really good education. At school, they can learn little more than the simple elements of primary instruction. It is in evening classes that they must continue and complete this education. Now that the general introduction of machinery into all trades has rendered almost obsolete the system of apprenticeship, it is in the evening school that the apprentice learns the principles of his trade, the history of its growth and development, and the direction in which he is to look for further improvements. It is, too, in the school that he learns to understand the processes and operations that are performed in the factory or shop. May we not say, then, that the industrial progress of a nation depends on the excellence and completeness of its organisation for the evening instruction of its workmen?

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## BRITISH ASSOCIATION.

### Abstracts of Papers.

#### TOWN LIFE AND PHYSICAL DEVELOPMENT.

DR. J. MILNER FOTHERGILL read a paper on the effect of town life upon the human body, in the course of which he said that as a hospital physician he had been struck by the physical inferiority of the denizens of towns as compared with country people. That town residence impaired the physique was a fact observed by Lugol, Hayles Walsh, Cantlie, and others. Special inquiries set on foot had resulted in proving the great rarity of a pure-bred cockney of the fourth generation. Of old life was practically a country life, with a walled town here and there. Now urban populations exceed in number the country folk of this country. Of old a strong physique for work or war was the one thing to be coveted. Now the active brain was what was required for success in the battle of life. In the middle ages the weakly retired to the cloister and the convent, while the race was reproduced by the strong. Now the offspring of the weakly could be reared by costly prepared foods. The children of to-day were alike the products of the weakly and the strong. The deterioration of town populations could be seen to be a reversion towards an earlier and lowlier ethnic form. The stolidity of the country child compared to the precocious development of the town child was largely due to the monotonous existence of the one as compared to the life of excitement led by the other. The demands of the nervous system in the town child led to a comparative starving of the other tissues of the body, while in the country child all grew alike in fit proportion. The digestive organs specially suffered, and the town dweller could not eat the food so largely in request in the country—pastry, cakes, meat pies, Yorkshire pudding, Norfolk dumplings, and Cornish pasties—because such food caused in him dyspepsia. In order to avoid the pains of indigestion the town dweller ate fish, bread, and meat. Especially was he fond of the sapid tasty meat, which was so easily procured in towns. But with the indoor life led, combined with an impure atmosphere, the oxidising processes were defective, and the presence of excrementitious matters in the blood set up in time that change in the kidneys and elsewhere commonly spoken of as "chronic Bright's disease," and for which it was now proposed to substitute the term "vasorenal change," as more applicable. Another consequence of the impairment of the digestive organs was the inability to take fat, by which the system was predisposed to pulmonary phthisis, consumption, and Bright's disease, separately or combined, and the maladies which formed the scourge of degenerating town populations, while their children succumbed to the maladies of childhood.

#### A REMARKABLE FOSSIL.

Professor H. G. Seeley exhibited a remarkable fossil, showing the development of the young of Plesiosaurus. Until this fossil had been found and forwarded to him he had sought throughout the collections of Europe for evidence on that development, but without success. No more remarkable fossil had ever been found, and no incident in the history of fossilisation was more singular than that which this specimen displayed. The fossil was a series of mummies of minute Plesiosaurus, less than five inches in length, which had the substance of their flesh perfectly preserved, and their bones preserved within the flesh. The remains showed different conditions of development. This was the only case that had ever occurred of the mineralisation of the muscular substance and the preservation of the external form of these animals; and so perfect was the preservation that the circle of the eye was preserved, and the constituent bones could be distinguished. Prof. Seeley also spoke on the reputed clavicles and interclavicles of Iguanodon, and expressed the opinion that what had hitherto been regarded as such clavicles and interclavicles must be turned round and referred to the pelvic region.

#### THE SUBSIDENCES AT NORTHWICH.

Mr. Thomas Ward read a paper entitled "The History and Cause of the Subsidences at Northwich and its Neighbourhood in the Salt Districts of Cheshire." He said: Northwich overlies extensive beds of salt, occupying about three square miles. The first or "top" rock-salt lies at a depth of about 50 yards from the surface, and is covered by Keuper marls, and these by the drift sands and marls. Between the two beds of salt there are 30 ft. of indurated Keuper marl. The second, or "bottom" rock salt, is over 30 yards in thickness. These beds of salt occupy the lowest portion of an old Triassic salt lake. The first bed of rock-salt was discovered in 1670, the second in 1781. The falling-in of a rock-salt mine is a very rare occurrence, and subsidences of this kind do not give rise to the reports which are met with in the newspapers. The first reported destruction of a mine was in 1750, and from that date to the end of the 18th century every two or three years a mine collapsed. In the present century, at considerable intervals of time, collapses of mines have occurred, but these with scarcely an exception were old abandoned "top" mines. The subsidences which are so destructive in the town of Northwich and the neighbourhood are entirely caused by the pumping of brine for the manufacture of white salt. It was only about 1770 or shortly afterwards that the first sinking was noticed; since that date subsidence has gone on very rapidly, and much destruction of property has resulted. Large lakes or "flashes," one of more than 100 acres in area, and of all depths up to 45 ft., have been and are being formed. The brine pumps set up a circulation of the salt water or brine lying on the rock-salt, which flows to the pumping centre. The brine thus removed is replaced by fresh water, which on its passage to the pump saturates itself, taking up sufficient salt to make a solution containing about 26 per cent. of salt. This continual removal of salt from the surface of the rock-salt lowers it, and the overlying earths either follow the diminishing surface continuously or else after remaining suspended for a time suddenly fall into the cavity from which the water has extracted the salt. The brine currents on their way to the pumping centres form deep valleys or troughs, and the surface of the ground overlying forms a fac-simile of these hollows. The property on the sloping sides of the valley is pulled to pieces and destroyed; the windows and doors all get out of form, owing to the unequal sinking of the various portions of the house. When, owing to the different nature of the marls and the abundance of sand overlying them, a sudden sinking takes place, the hole extends to the surface and swallows up anything upon the surface—as a horse in a stable, barrels of beer in a cellar, or water-butts and other utensils in a yard. The damage done to property is enormous, but thus far no human life has been lost.

UNDERGROUND WATERS IN ENGLAND.

Mr. E. E. de Rance read a "Report on the Underground Waters in the Permeable Formations of England." He said the remarkable drought the country had experienced this year had brought in strong relief the advantage of public water supplies being derived from underground sources, the rainfall of wet periods being not only stored in the sandstone rocks, but delivered filtered from organic impurity and at a constant equable temperature. Notwithstanding the unprecedented period of dry weather, public wells of Liverpool, Birkenhead, Birmingham, Southport, Nottingham, South Staffordshire, and the Staffordshire Potteries Waterworks gave their daily supply undiminished, while the gravitation works of the Manchester Corporation and the whole of the East Lancashire towns had been on short supply, and in some instances had failed altogether. The new and successful borings of the Potteries waterworks and that of the Gainsborough Local Board were described, and the results given of a large number of borings in the Midland counties. The levels taken at a well at Bocking, in Essex, for several years showed that the water level was uplifted by the Essex earthquake of April 22, 1884. This acquired level was gradually diminishing at a rate which would bring back the original level by August next year. The unfortunate failing of the Enson Moor boring of the Stafford Corporation was due to an influx of weak brine derived from the new red sandstone. The water committee of that town, at the very moment of apparent success, had now to sink a new source of supply for their borough.

## NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

### Abridgment of the Presidential Address of Sir Lowthian Bell, F.R.S.

In the year 1839, and therefore just short of half a century ago, it fell within my duty to undertake a journey of upwards of 10,000 miles on the mainland of Europe. To its performance nine months were devoted, and the Continent, from North to South and from sea to sea, was crossed four times by as many different routes. Before starting on this expedition from England, and during it, practically every mile of public railway then in existence was travelled over, and this did not greatly, if indeed it did, exceed 300 miles in length. Contrast this with the 280,000 miles built since that date, and fancy, if you can, the perpetual movement rushing along them. As a factor in the calculation, we had, in one year, conveyed along the 17,000 miles of line in the United Kingdom 700 millions of passengers, almost equal to half the population of the globe; and 270 million tons of goods and minerals. The germ out of which the modern railway sprung was sown nearly 200 years before the opening of the Stockton and Darlington line, the first undertaking of its kind in the world. It originated with a colliery owner of the name of Beaumont, in the immediate neighbourhood of Newcastle. The rails he employed were of wood, the partial use of which was continued, within my own recollection, for conveying coals to the Tyne for shipment. Cast, as well as wrought iron, had been employed for rails, but only sparingly previous to their more general introduction in the adjoining coalfield. It was not, however, until 1821 that anything was heard of a malleable iron rail, rolled expressly for this purpose. In that year the Directors of the Stockton and Darlington Railway decided to lay a portion of their intended line with cast iron and the remainder with an iron rail invented by Mr. Birkinshaw of Bedlington, in Northumberland. They were rolled in lengths of 12 or 15 feet and weighed 28 lbs. per yard. This was as heavy a mass as the machinery of those days could deal with; and it offers a striking contrast with the practice of the present time, when we have a united force of 7,000 horse power, turning out above 400 tons of 82 lb. rails in 12 hours in lengths of more than 120 feet.

The mechanical appliances called into existence by railways are almost infinite in their number, and some of them are most ingenious in their design; but it was the locomotive engine which proved the key to the success which was ultimately achieved. The idea of propelling a machine by steam, which in its turn should be capable of drawing loaded carriages along a railroad, was not a new one. On the contrary, it had engaged the attention of several mechanicians; but it was not until 1813, when Hedley placed a locomotive on the Wylam Colliery wagonway, which continued successfully for several years to draw the produce of Mr. Blackett's pits to the shipping place at Lemington, that any practical result was obtained. At this point of its history the question engaged the attention of George Stephenson, who had removed from Wylam to Killingworth Colliery, where ultimately he enjoyed the advantage of the advice and assistance of Nicholas Wood, one of the founders and first President of our Institute. The first locomotive Stephenson built at Killingworth ran for years on the colliery railway, and is now to be seen, thanks to the owners of that concern, on the High Level Bridge, a highly interesting record in the history of this truly national invention. Some few years after Stephenson had taken up his residence at Killingworth he entered into an engagement with Losh, Wilson, and Bell, formerly of Newcastle, to superintend the construction of locomotives. This modest beginning was, I believe, the first attempt to organise their manufacture on a commercial scale. It was, however, some years before this new form of engine could be trusted to overcome the impediment presented by even a moderate gradient. In consequence of this want of power the Directors of the Stockton and Darlington Railway, under the advice of Stephenson, who had been appointed their engineer, adhered to the old colliery plan of using stationary engines and ropes, except in cases where the country permitted the construction of the line level enough to be capable of being worked by locomotive power. Some seven years after the opening of the railway just named, Stephenson obtained the prize of £500, offered by the Liverpool and Manchester Company, for his famous Rocket engine, a model of which, as well as those of other early designs, may be seen in the Exhibition now open in this city. Not even the measure of success which attended the performance of this last attempt of our great local engineer sufficed to inspire the promoters of the Newcastle and Carlisle Railway with sufficient confidence to adopt it as the moving power on their line. By the recommendation of a committee, appointed to inquire into the subject, it was determined to work the entire line with fixed engines, and, in consequence, no parliamentary authority was sought for to use locomotives. Before, however, the first section of this railway was ready for public traffic, which happened in 1835, the Directors wisely abandoned the idea of ropes, and opened the line with two engines built in Newcastle, at the works of R. Stephenson and Co., and R. and W. Hawthorn.

From the time when Hedley placed his engine, running about five miles an hour, on the Wylam Railway, to the day when Stephenson built the Rocket, capable of running nearly thirty miles an hour, seventeen years had elapsed. To understand, what now would be considered this slow rate of progress, we must recollect the means possessed by mechanical engineers fifty or sixty years ago. The iron foundries on the Tyne were incapable of making castings exceeding a few hundredweights, and for want of the tools found now in every engineering shop, almost every kind of fitting work was done by hand. The success of a locomotive engine depends on its compactness and perfection of workmanship, so as to fit it, among other things, to use steam at a high pressure. All this involves an amount of accuracy which can only be secured by the admirable machine tools with which we are now so familiar. Besides accuracy of execution the workmanship of our own time has the further advantage of economy. I remember hearing from my father that the iron work of the engine erected by Boulton and Watt, at Walker, was charged 2s. 6d. per lb., equal therefore to £285 per ton; and for this high price the fittings were of the rudest description; rattling, when the machinery was at work, as if it might tumble to pieces at any moment. For about one-fifth of this rate we can now purchase a locomotive engine with a fire-box of copper, and almost all its other parts of steel, built, and much of it polished with all the care necessary for forming part of a delicate instrument intended for philosophical research.

While a net-work of railways was gradually being extended over the face of the United Kingdom, the Continent of Europe was following the example we had set. The result, as we all know, has been, that travelling, or land transport of any kind, is now rarely performed in the manner which was all but universal 50 years ago. To no nation however has the railway rendered greater service than to the United States of America. It is true nature has furnished their vast extent of territory with large means of water communication; but enormous as is the volume of such a river as drains the Valley of the Mississippi, by far the greater portion of its area, extending over one and a half million square miles, is inaccessible either by the main stream or its tributaries. This want, and others of a similar kind elsewhere, are being constantly lessened by the construction of hundreds, it may in truth be said of thousands, of miles of railways on the American Continent.

In our own country, as well as on the mainland of Europe, in America, and now in Asia, the locomotive is bringing down the produce of the interior to the sea coast, ready to be carried over sea for the use of other populations. It is therefore not to be wondered at that steam was looked to as a means of rendering the same service on the ocean that it had afforded on the land. I deemed it needless to say, in the case of railways, that there were those who, ignorant of the quantity of heat capable of being afforded by a given weight of coal, or unaware of the mechanical duty it represented, would have disbelieved the statement that 30 lbs. of coal was able to drag a train weighing 300 or 400 tons one mile at the rate of 50 miles an hour or more. To such the success of the locomotive was for a long time a matter of doubt, and with them an opinion of Dr. Lardner in reference to transatlantic steam navigation probably had great weight. On the authority of this professor of physical science, the world was informed that it would be difficult, if not impossible, to construct a ship able to carry enough coal to be propelled by steam power across the Atlantic. It is true when Dr. Lardner propounded this doctrine, Joule had not ascertained the mechanical equivalent of heat; but in the absence of any knowledge of the value of this essential factor in the calculation, it was premature to found an estimate upon the performance of an engine constructed for using heat itself as a moving power.

Before entering upon the few details which it is proposed to submit upon shipping, I would remind you of its extent to-day as compared with what it was 50 years ago. At the last-mentioned date the tonnage sailing under the British flag may be taken at 750,000 tons, of which a little above 50,000 tons consisted of steamers. By the end of 1885 this country possessed 3,456,562 tons of sailing ships and 3,973,483 tons of steam vessels, together 7,430,045 tons. Inasmuch however as a ship propelled by steam is calculated to make $3\frac{1}{2}$ times as many voyages as one propelled by wind, the actual carrying power of our mercantile fleet may be regarded as being now twenty times that which it was half a century ago; and that four-fifths of its work is now being performed by the assistance of the produce of our collieries. It will always be a satisfaction to the people of Newcastle, that the credit of proving the superiority of steam vessels for carrying cargoes belongs to their townsman Sir Charles M. Palmer. This he did some 35 years ago by building the "John Bowes," which, notwithstanding her age, continues to perform excellent service. The enormous increase of traffic across the ocean implied in the figures just given, is, as I shall hereafter have occasion to show, in a great measure, a direct consequence of the improved mode afforded by railways, of dealing with the traffic on land. (*To be continued.*)

## MANUAL TRAINING: A MAIN FEATURE IN NATIONAL EDUCATION.

Abstract of a Paper Read at the Meeting of the British Association by Mr. W. Mather, M.Inst.C.E.

THE question of remodelling the methods of Education is now engaging the attention of Governments and leading men in all civilised countries. With one consent, the civilised nations have arrived at the conviction that "knowledge is power." A compact population, inexhaustible resources, accumulated wealth, settled political relations, good climate, and fertile land—these and other like advantages no longer inspire complete confidence in countries where they exist, for evidence multiplies on every hand that the chief factor in a nation's prosperity is not the bounty of Nature, but the human intelligence whereby its blessings may be utilised. The British Association, through the addresses of its Presidents, has more than once proclaimed this truth to the world, notably by Sir Lyon Playfair, at Aberdeen, and a few days ago by its newly-elected president, Sir Henry Roscoe. The former told us that in the future, notwithstanding all our matchless resources, the "competition of the world would be the competition of intellect"; the latter implies the same truth in expressing the apprehension "that the English people do not possess, as yet, the value of science so characteristic of some other nations." Nations cannot adopt systems and methods precisely alike. The English-speaking people will naturally adopt methods differing from the German, French, or Italian; and probably America and our Colonies will afford to us, and we to them, the chief fields of experience by which we may learn the best methods of instruction. The German Empire enjoys at present the most comprehensive plan, especially noteworthy for the commercial and scientific training available for the youth of every class. Apart altogether from the schools of general education, there are about 250 institutions giving scientific and technical instruction in special branches of industry, and handicraft or trade schools. The results are not commensurate with the time spent at the schools, or with the money expended in establishing and maintaining them so far as practical knowledge or constructive ability are concerned in the *mechanical* trades. In the chemical industries the results are, however, eminently satisfactory, and the commercial training of the schools is especially practical and valuable. We can learn from Germany, therefore, what to emulate and what to avoid. There are now many schemes suggested, and others have been already started, in England for technical instruction. None of them will be of much avail for our working class as a whole, but all may become of great value for the sons of employers, managers, foremen, and others who have the requisite means and abilities to pursue a scientific and technological training systematically before entering the workshops and manufactories. Such schools of technical instruction will also be of great service in the training of teachers for the Public Elementary Schools. It is believed by many who, like myself, are employers of labour, and who come into close relations with the children of the working classes as they pass from school to work, that the present methods of teaching do not meet the wants of the nation, or do justice to the children who are compelled to attend our Public Elementary Schools. Since the passing of the Education Act of 1870, many changes and improvements have been made in the Education Code; but the traditional principle of teaching has not been reformed. Memory, rather than the whole mind, is appealed to; names, dates, events, grammar, rhetoric, and literature engage an unreasonable share of the school time. The natural sciences, recently introduced into our school courses in the higher grades as special subjects, still hold a secondary place in the order of studies; oral teaching and text books more than experimental work and illustrations are employed in these branches, and too little time allowed for the mental digestion and assimilation of scientific truths. In class subjects, it has long been acknowledged that "object lessons" and pictorial illustrations greatly facilitate the efforts of teachers, and aid the comprehension of children, although in these cases the faculty of observation alone is exercised. How much greater, then, would be the benefit to teacher and pupil if to observation were added the exercise of the faculty of execution and production in order that the conception of a truth or fact in the mind should eventuate in the creation of an object with the hands embodying such truth or fact? Now, keeping in view the wants of the nation and the obvious fact that all the children in our Public Elementary Schools must begin to earn a living very early in life, the whole spirit and purpose of our teaching should be to render knowledge serviceable by making it thorough and practical and part of the very being of the boy and girl. It is of secondary importance, after reading and writing have been acquired to serve as useful instruments, to pursue systematically the study of grammar, language, and literature, analysis of sentences, refinement of composition, elegance of expression, and remote historical events. An American authority, General Francis Walker, the distinguished President of the Boston School of Technology, U.S.A., the best technical school in the world, judged by its practical results, has said: "There is an alphabet to pass through before the works of our poets and philosophers can be understood and appreciated, and in like manner the alphabet of the sciences should be known long before the mind is sufficiently matured to fully comprehend the phenomena of nature. Our scholars go through nursery rhymes and fairy tales in earliest youth. We do not wait until the twelfth or fourteenth year before instructing our children in the rudiments of language which will enable them to appreciate poetry, and yet in science our traditional method is to postpone its revelations until the school period of most boys in our elementary schools is drawing to a close. In morals our children are made to commit to memory truths, facts, and laws for the guidance of human conduct, long before they appreciate the significance of these truths upon their well-being." The origin of light, the laws of its action and its use, may be taught long before the science of optics can be systematically pursued. Knowledge of the law of atmospheric pressure, acting through a common pump from which the child fetches water for the household, is surely as important in its educational effect as the ability to spell correctly words of several syllables. So with geometry; to classify objects and bodies that surround a child, and to shew by dividing and subdividing what a number and variety of forms can be derived from one object; to accustom the eye to measure correctly and to estimate distance and direction accurately; all these elements of geometry can be conveyed to a child long before the study of Euclid is seriously begun. The difference between solids and liquids can as readily be taught in the earliest years as the difference between a noun and a verb, and the passing of a liquid into a vapour may be so easily comprehended that a child will be led to watch with educational effect his mother's tea kettle singing on the hob. The simple laws of mechanics can be made so clear to a child, that his games of marbles, football, and cricket, supply illustrations of their operation to himself. So heat, sound, and motion, that daily surround the child, may be comprehended sufficiently to give more interest to life, and to produce perception and reflection, in some degree, long before their laws can be fully understood, just as melody has its influence before a knowledge of music can be acquired. But in acquiring such knowledge of the natural sciences in the most elementary stages *it is absolutely necessary to use the hand as a means of access to the mind and understanding.* Thus manual training becomes a necessity if subjects other than literary are to be efficiently taught, and the urgent need of such teaching is no longer a matter of controversy.

It is remarkable that the hand has hitherto been so little employed in our methods of instruction. Much time is now spent in handwriting, and it is the only obligatory subject in our Education Code in which the hand is used. Drawing is of much greater importance, though both are essential, yet drawing is not obligatory in our public schools. Mechanical and freehand drawing should be the foundation of instruction in all subjects not purely abstract. It expresses thought in form, and likewise develops thought. In the study of geography its importance cannot be over-estimated as a means of acquiring correct ideas as to distance, areas, and localities, and topographical conditions of mountains, lakes, and rivers. In the study of geometry, drawing is the only means by which language is made intelligible as applied to that subject. In the study of art and nature, drawing makes imagination visible, and reproduces the beauty and grace of form and proportion abounding in the external world. In the study of the natural sciences, drawing assists to illustrate the operations of all the natural laws, by graphic representations of the objects subject to them or forming the media through which the laws are rendered serviceable to man. Drawing is the first step in manual instruction, and its value cannot be over-estimated; there is a direct connection between the drawing and the technical operation of producing. The mind is trained to judge, from a drawing on the flat, of all the proportions of the object portrayed; and, on the other hand, the correct representations of objects by drawing is rendered easy through the constant practice of expressing abstract forms in concrete objects fashioned by the hands through all the stages of development.

As an employer I have had opportunities of testing the quality of the education given in our public schools by selecting boys who have passed the examinations brilliantly, and whose school record stood very high even in science subjects. My experience has been sufficient to convince me that the method of teaching in our Public Elementary Schools, admirable as it is in giving a higher tone to our working classes, and in developing considerable literary power, yet in the main is one-sided in its effect, even on a really gifted boy; while it does nothing to call forth the practical faculties in boys who, slow and even stupid in the class room, may possess considerable aptitude in acquiring knowledge after they have begun to work for a living.

Upon the agricultural working classes a great boon would be conferred in affording facilities for their children to become early instructed in the elements of science underlying successful husbandry, by the creative method, in combination with subjects of general education. In their occupations they deal with nature at every point. The knowledge of her laws is necessary to intelligent labour, if the fruits of the earth are to be cultivated and enjoyed more abundantly.

In America manual training schools are being rapidly established in connection with the public school system. During a recent visit I saw many of them, and was greatly impressed with the admirable results achieved. I observed that since my former visit four years ago, when I made the inquiry throughout the United States for the Royal Commission on Technical Instruction, many manual training schools have been established in towns by the school authorities to take the place of the grammar or second grade school in their system, and it is not too much to say that within ten years in all large cities manual training will be established and become a main feature in public education in the secondary schools.

About two millions of children and young people are already participating, in some degree, in this recent development towards practical education in America. There is no one cut and dried plan. Each one of the cities now committing itself to industrial and art education will seek to eclipse its neighbours. This freedom of choice is the mainspring of success, for it enables local sentiment and characteristics to exert their utmost influence in the selection of methods of instruction, and in the equipment of schools best adapted to the school population.

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## NATIONAL ASSOCIATION FOR THE PROMOTION OF TECHNICAL EDUCATION.

According to the prospectus of this Association just issued, its general aim will be to bring into force the recommendations already made by several Royal Commissions, as well as to effect such reforms in our educational system as will develop in the best way the intelligence of those of all classes upon whom our industries depend. The following objects will probably engage the early attention of the Association:—

1. The encouragement of Educational Reform, whether by legislation or otherwise, to be carried out by the following amongst other means:—

(*a*) The promotion in our primary schools of the better training of the hand and eye by improved instruction in drawing, in the elements of science, and the elementary use of tools.

(*b*) The introduction of such changes in the present system of primary instruction as may be necessary to enable children to take advantage of technical teaching.

(*c*) The more extended provision of higher elementary schools, where technical education may be provided for those who are fit to take advantage of it.

(*d*) The reform of the present system of Evening Schools, with special provisions for the encouragement of Technical (including Commercial and Agricultural) instruction.

(*e*) The development, organisation, and maintenance of a system of Secondary Education throughout the country, with a view to placing the higher Technical Education in our Schools and Colleges on a better footing.

(*f*) The improvement of the training of teachers, so that they may take an effective part in the work which the Association desires to forward.

2. The formation of a central consultative body, which will give opportunities for conference between persons of various classes and from different localities, will form and influence public opinion, and will obtain public support for the furtherance of Technical Education.

3. The collection of information as to the existing means for carrying out the work of Technical Education, and the best methods of extending and organising it throughout the United Kingdom.

4. The preparation, in a popular form, of information to be obtained from Reports of Commissions, Consular Reports, and from various other sources (including, if necessary, special inquiries at home and abroad), for diffusion throughout the country.

By these and other means the Association desires to bring about the organisation and co-ordination of the Industrial Education of both sexes in accordance with the needs of various localities; and with the view of assisting the Executive Committee in their work, sub-committees in connection with the following subjects are being formed:—

Technical Education in relation to Elementary Schools.
Higher Technical Education.
Technical Education in relation to Agriculture.
Commercial Education.

## REVIEWS.

*Treatise on Animal Alkaloids, Ptomaines, and Leucomaines.* By Dr. A. M. Brown. Baillière, Tindall, and Cox.

This most interesting question is fully gone into, bringing up the record of discovery and clinical labour to the latest date. The book will receive additional interest from the fact that the well-known Armand Gautier, of the Paris Faculty of Medicine, has especially written an introduction for the work. The curious phases of auto-infection, typhusation, and intoxication, are very elaborately dealt with, and this portion of the work has already attracted the attention and praise of Sir William Aitken.

*Practical Amateur Photography.* By C. C. Vevers. Horsforth, Leeds.

It is simply and clearly expressed, and cannot fail to be understood by beginners, for whom it is chiefly intended. In the second part there are some useful hints for more advanced amateurs.

## BOOKS RECEIVED.

"Programme of Technological Examinations, Session 1887-88, City and Guilds of London Institute."

Gives a syllabus of subjects for the next examination, as well as the examination questions of the previous session. It shows the great advance in the work of the Institute and the numerous branches of industry it deals with.

"Technology Quarterly." Boston, U.S. Vol. i., No. 1.

Contains accounts of the results of original investigations in the chemical, physical, and other laboratories of the Massachusetts Institute of Technology. It is ably edited by a board of editors chosen from the Senior and Junior Classes of the Institute.

"Stevens Indicator." Hoboken, U.S. Nos. 2 and 3.

The organ of the Stevens Institute of Technology.

"The Bookbinder." No. 1. London: Clowes and Sons, Ltd.

Well printed and illustrated. A useful and welcome addition to our special journals.

"Journal of the Society of Chemical Industry," July, August.

Good as usual.

"The Naturalists' Monthly." London: Walter Scott. Vol. i., No. 1.

Contains articles and notes on Natural History; and the first part of a feeble Biography of Darwin.

"Institution of Mechanical Engineers," May, 1887. No. 2.

Contains the President's address on Fifty Years' Progress in Gun Making," and an exhaustive paper on Canadian Locomotives.

## SCIENTIFIC MEETINGS AND EXHIBITIONS.

Royal Institution.—We understand that Sir Robert Ball is about to give a course of six lectures at this Institution.

The Academy of Sciences.—Mme. Foehr, lately deceased in Paris, has given to the Academy a sum of 40,000f. to be invested in national stock, and the income is to be awarded yearly, under the name of "Dellion Prize," to a meritorious work or paper on the art of healing. Another benefactor has just left a bequest sufficient to found a 2,000f. prize to be given every second year, and to be known as the "Pourrat Prize," after the name of the founder. It is to reward the best work on a medical or surgical question to be selected by the Academy.

Exhibition at Berlin.—Next May there will be an exhibition of the work of Berlin apprentices in all the principal industries, and of the pupils of the various technical and trade schools of Berlin.

St. Petersburg Exhibition.—The following notice has been circulated by the Foreign Office:—The Secretary of State for Foreign Affairs has received information that the Imperial Polytechnical Society of Russia intend to hold an exhibition of illuminating apparatus and of the naphtha industry at St. Petersburg during November next. Further particulars may probably appear in the *Board of Trade Journal.*

International Competition at Brussels.—A great international competition of industries will take place at Brussels next year. The object of the gathering is to show what kind of work can be turned out by workmen with their tools, many of them of the plainest description.

Civil and Mechanical Engineers' Society.—The offices of this society have been removed to 6, Queen Anne's Gate, Westminster, S.W., where future meetings will be held.

Proposed Entomological Society at Birmingham.—It is intended to form, some time during the present autumn, an entomological society in Birmingham. All who wish to join should apply to W. Harcourt Bath, hon. sec. *(pro tem.)*, Ladywood, Birmingham.

The French Gas Association.—This association offers a prize of one thousand francs, open to all the world, for the best essay on the ventilation of buildings lighted by gas, special attention being paid to the utilisation of gas itself as a means of ventilation. The essays must be written in French, and sent in before May 15th, 1888.

Institution of Mechanical Engineers.—At the ordinary general meeting of this Institution about to be held, the chair will be taken by Mr. E. H. Carbutt, and after the nomination of officers and other formal business the discussion will be resumed on the paper read by Major English, R.E., at the previous meeting, on "Experiments on the Distribution of Heat in a Stationary Steam-engine." A paper will also be read by Mr. J. Richards, of San Francisco, on "Irrigating Machinery on the Pacific Coast."

King's College—Metallurgical Department.—In addition to lectures to be delivered by Professor Huntington on Monday and Friday afternoons, on and after the 10th October, evening lectures will be given on Mondays, fron eight to nine, on "Metallurgy," and from seven to eight on "Fuel." A special course of evening University lectures on the "Manufacture and Use of Iron and Steel" will also be given by the demonstrator on Thursdays, from seven to eight, commencing with a free public lecture on "The Ores of Iron and primitive Methods of Dealing with them," on the 13th October.

Gresham Lectures.—The lectures founded by Sir Thomas Gresham will be read to the public in the theatre of Gresham College, Basinghall Street, on the following days, commencing each day at six o'clock:—Physic (Dr. Symes Thompson), October 4, 5, 6, and 7; Rhetoric (Mr. Nixon), October 11, 12, 13, and 14; Astronomy (Rev. E. Ledger), October 18, 19, 20, and 21; Law (Judge Abdy), October 25, 26, 27, and 28; Geometry (Dean of Exeter), November 1, 2, 3, and 4; Divinity (Dean of Chichester), November 7, 8, 10, and 11; and Music (Dr. H. Wylde), November 15, 16, 17, and 18.

Natural Gas in Minnesota.—Natural gas has been discovered in the southern part of Minnesota, and three wells lately sunk have produced an immense flow of gas. A company has been formed to work gas wells on 10,000 acres of land.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

10885.—OSCAR HAMMERSTEIN, 52, Chancery Lane, London. "Art of forming long fillings for cigars." (Complete specification.) 9th August, 1887.

10887.—GREENWOOD KING, 3, Bank Chambers, Keighley. "Machines for cutting files." 9th August, 1887.

10913.—JOHN ROLPH McCARTEY, 53, Chancery Lane, London. "Permanent way of railways." 9th August, 1887.

10918.—FREDERICK WILLIAM DAHNE, 21, Cockspur Street, London. "Refining copper, copper regulus, and copper precipitate, and more especially such copper products as contain arsenic and other volatile impurities." 9th August, 1887.

10931.—WILLIAM HUTCHINSON, 15, Kirkham Street, Weaste, Salford. "An improved drying cylinder, with improved expander combined." 10th August, 1887.

10937.—FREDERICK HENRY GURNEY, 2, Woodstock Street, Oxford Street, London. "Self-adjusting soft inodorous india-rubber pad for the relief of hernia." 10th August, 1887.

10945.—ROLAND HUGH EDWARDS and GRAHAM WILLIAM BETHAM EDWARDS, 34, Southampton Buildings, London. "Mathematical instruments." 10th August, 1887.

10957.—LUDWIG MOND, 323, High Holborn, London. "Treating solids by gases, also applicable to other purposes." 10th August, 1887.

10992.—WILLIAM HENRY STEAD, 6, Lord Street, Liverpool. "Treatment of cotton seed for the removal of fibrous matters therefrom, and in apparatus therefor." 11th August, 1887.

11017.—JOHN LEEMING, Town Hall Buildings, Halifax. "Taking up motions of looms for weaving." 12th August, 1887.

11020.—GEORGE CHRISTIE and ALEXANDER DUNLOP, 55, Ladywell Street, Glasgow. "Wire-drawing machinery." 12th August, 1887.

11040.—TOM COOKE and WILLIAM HENRY BOYENS, 323, High Holborn, London. "Medicinal baths, applicable for other purposes." 12th August 1887.

11041.—ROBERT EDWARDS, 6, Lord Street, Liverpool. "Lithographic stones formed out of certain natural silicates, and the removal of the lithographic ink therefrom." 12th August, 1887.

11067.—JULIAN MONEY VERNON MONEY-KENT and SIDNEY SHARP, 70, Chancery Lane, London. "Construction and working of electric railways." 13th August, 1887.

11069.—WILLIAM HENRY DUNCAN, Coalbrook-dale, Shropshire "Endless tobogganing slide, sloping railway, and skating decline, elevated by power." 13th August, 1887.

11089.—GEORGE EUSTACE SKLIROS, 289, Regent Street, London. "The wheel or siren breakwater." 13th August, 1887.

11100.—JOSHUA MURGATROYD, 3, Beaumont Street, Mount Pleasant, Batley. "Letting-off motion of power looms." 15th August, 1887.

11115.—WILLIAM PATRICK KELLY, 54, Fleet Street, London. "A new composition to be used as a lubricant." 15th August, 1887.

11149.—JAMES CASTLE, ELEANOR CASTLE, and EDMUND BRAITHWAITE, 77, Chancery Lane, London. "Arrangement of reflectors for distributing, concentrating, increasing, and shading artificial light." 15th August, 1887.

11167.—JAMES KELMAN, 42, Maryhall Street, Kirkcaldy, N.B. "Electric differential dial indicator for telegraphic, telephonic, and electric bell purposes." 16th August, 1887.

11181.—JACOB HAYS LINVILLE, 24, Southampton Buildings, London. "Printing telegraphs." (Complete specification.) 16th August, 1887.

11188.—HENRY HARRIS LAKE. A communication from Willard Erastus Case, United States. "Conversion of chemical energy into electrical energy and apparatus therefor." (Complete specification.) 16th August, 1887.

11200.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from James Francis McLaughlin, United States. "Electrical motors." (Complete specification.) 16th August, 1887.

11213.—THOMAS JOSEPH DIGBY, 71, St. Paul's Road, Camden Town, London. "Electrical accumulators or secondary batteries." 17th August, 1887.

11252.—HENRY MOWER, 47, Lincoln's Inn Fields, London. "Secondary batteries or electrical accumulators." 17th August, 1887.

11275.—JAMES SEED, 4, St. Ann's Square, Manchester. "Spinning and doubling cotton and other fibrous substances." 18th August, 1887.

11285.—ROBERT HANNAN, 23, Southampton Buildings, London. A communication from James Joseph Charles Smith, United States. "Rubber composition strips used in the manufacture of insulated wires and cables." 18th August, 1887.

11289.—JULIUS GRETH, 8, Quality Court, London. "Coloured photographic printing." 18th August, 1887.

11331.—ROBERT MORTON, of the firm of Alexander Morton and Co., and GAVIN MORTON, 62, St. Vincent Street, Glasgow. "Manufacture of Axminster or chenille carpets and other fur-pile fabrics, and in apparatus therefor." 19th August, 1887.

11351.—CHARLES HENRY MALLHAM, George Street, Sheffield. "Cartridge extractors for drop-down guns." 19th August, 1887.

11356.—CHARLES RUNELS, 67, Strand, London. "Electric couplings." (Complete specification.) 19th August, 1887.

11361.—JOHN SAMUEL ROSS and HENRY BAINES, 15, Gunterstone Road, West Kensington, London. "Automatic apparatus for facilitating telephonic communication." 19th August, 1887.

11385.—THOMAS ALOYSIUS SEGRAVE, 10, Leinster Street, Dublin. "New or improved continuous screw-propeller for ships." 20th August, 1887.

11388.—CHARLES HARVEY, George Street, Sheffield. "Spikes for holding down railway-chairs and other like purposes." 20th August, 1887.

11390.—JAMES SHANNAN STEVENSON, 47, Lincoln's Inn Fields, London. "Manufacture of elements or plates for secondary batteries or electrical accumulators." 20th August, 1887.

11415.—ALFRED WILLIAM ARMSTRONG, 132, Southwark Street, London. "Adaptation of the electric light or heat from primary or secondary batteries in conjunction with the mechanism of an automatic delivery box weighing-machine, or other machines for similar purposes." 22nd August, 1887.

11448.—JOHN SCUDAMORE SELLON, 47, Lincoln's Inn Fields, London. "Secondary batteries or electrical accumulators." 22nd August, 1887.

11451.—LADISLAS NIEVSKY and BUTLER HUMPHREYS, 5, Elms Road, North Dulwich, London. "Automatic fire-alarm." 23rd August, 1887.

11454.—EDWIN H. B. LYNE, 54, London Street, Fitzroy Square, London. "Photographic print washer." 23rd August, 1887.

11463.—ROBERT CRAIB ROSS, 4, St. Ann's Square, Manchester. "Galleys, chases, and frames for printers' use." 23rd August, 1887.

11478.—LEON LAURENT LEFEVRE, junr., 45, Southampton Buildings, London. A communication from Clement Payen, United States. "Crystallised metal, and articles made thereof." 23rd August, 1887.

11483.—GEORGE CLULOW and JOHN LOADER, 169, Fleet Street, London. "Adjusting the seats of music stools, and other like articles." 23rd August, 1887.

11496.—ALFRED JULIUS BOULT, 323, High Holborn, London. A communication from Franz Czech, Austria. "Decorating ceramic ware." (Complete specification.) 23rd August, 1887.

11502.—EDWARD FREDERICK HERMANN HEINRICH LAUCKERT, 28, Southampton Buildings, London. "Dynamo-electric and electro-dynamic machines." 23rd August, 1887.

11517.—HARRY WHITESIDE COOK, 54, Fleet Street, London. "Apparatus for controlling steam-engines by electricity." 24th August, 1887.

11528.—JOHN ARTHUR DRAYTON and MICHAEL PATRICK McCOY, 55 and 56, Chancery Lane, London. "Casting printers' composition rollers." 24th August, 1887.

11535.—HENRY FRANCIS JOEL, 44, Lavender Grove, Dalston, London. "Pneumatic bells and signals." 24th August, 1887.

11568.—JACQUES DAVID, 77, Chancery Lane, London. "Electrically driven sewing machines." 25th August, 1887.

11578.—GEORGE SHEPHEARD and HENRY FRANCIS HOLMAN, 35, Southampton Buildings, London. "Determining the range for guns or other firearms." 25th August, 1887.

11598.—RICHARD ALVIN BREUL, 52, Chancery Lane, London. "Wire chain." (Complete specification.) 26th August, 1887.

11604.—ALFRED STEER, 13, Grosvenor Street, Camberwell, and EDMUND OCTAVIUS EATON, 28, Martin's Lane, Cannon Street. "Means for facilitating the delivery of prepaid goods." 26th August, 1887.

11612.—HUGO MARTINZ, 33, Chancery Lane, London. "Dressing textile fibres." (Complete specification.) 26th August, 1887.

11623.—HENRY WILLIAM HOLLAND, 98, New Bond Street, and JOHN ROBERTSON, 4, Dansey Road, London. "Extractor mechanism for drop-down small-arms." 26th August, 1887.

11631.—WILLIAM FOREST BOWEN, 288, Halliwell Road, Bolton. "Regulating and controlling the speed of steam and other engines." 27th August, 1887.

# Scientific News

## FOR GENERAL READERS.

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CONTENTS.



## CURRENT EVENTS.

Sanitary Science.—While in England we have had the annual congress of the Sanitary Institute, almost at the same time there was held in Vienna the International Hygienic Congress. The President of the Sanitary Institute, Lord Basing, made no attempt to discuss the subject from its scientific side, but dealt chiefly with recent legislative enactments and the "policy of sewage." In his opinion further legislation is required on such subjects as the construction and use of sewers and drains, scavenging, the protection of the sources of water supply, and the control of infectious diseases. At the same time he showed that since the passing of the Public Health Act in 1875, the average death-rate throughout the country had diminished from 20·9 to 19·3 per thousand. At Rugby it had been reduced from 24 to 12, at Dover from 28 to 14, and at Salisbury from 40 to 16. At Matlock it had fallen from 18 to 9, and he was of opinion that with care and suitable legislation the average rate might well be reduced from 19 to 14 per thousand.

At Vienna there was a very large and influential gathering, and many subjects of importance were brought forward. In an address by M. Brouardel, he expressed the opinion that typhoid fever is far more dangerous than cholera, and that 80 per cent. of the cases are caused by polluted water, and that therefore the condition of the water supply must always be a very important consideration in hygienic administration. Herr Pettenkofer gave an address on hygienic instruction in Universities and technical schools, and spoke strongly of the importance of spreading the principles of sanitary science among all classes of society. He spoke very favourably of the advances made in England, and proved by statistics that our rate of mortality had been sensibly reduced by attention to sanitary requirements.

On the subject of quarantine, he denied that the English were responsible for cholera coming to Europe through the Suez Canal, and said that we were frequently visited by the disease before the Suez Canal was opened. Since that time the epidemic has appeared in many European countries, while Great Britain, which now stands accused, and has suffered much from cholera in former times, remains free from it. Why, he asked, do not the English, in spite of their enormous traffic with India, where the cholera is never extinct, transfer the disease to their own country? On looking more closely into the matter, he said it must be admitted that England's immunity from cholera since 1866 was not caused by quarantines and other expensive obstructions to international traffic, and he hoped that Italy, France, Spain, Russia, Germany, and Austria would follow England's example.

Foreign Competition.—It is well known that as a rule the Germans are methodical and careful in studying in detail the best means of attaining their end, and if in some cases they are somewhat slow to imitate, they certainly bring skill and technical knowledge to bear on their processes of manufacture. They also give much more attention to the testing of their products than is usually the case in England. An instance of this was lately referred to in *Industries*, in which attention was called to the care with which gunpowder made in Germany is tested practically by the manufacturers. The German Company who make the "cocoa" powder now used for large guns have a test ground adjoining their factories, and there every batch of powder made is tested, not in a small experimental piece, but in a six-inch gun. If the velocity of the shot is too high and the pressure developed in the gun too great, the batch of powder being tried is mixed with a weaker batch. If, on the other hand, the velocity and pressure are below the prescribed limit, the batch on trial is mixed with a stronger batch. This, however, should hardly be a matter of surprise, for one would expect that such a process of selection would at once suggest itself as necessary when dealing with a subject of so great importance.

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In England, however, according to our usually well-informed contemporary, no gunpowder maker has yet thought it worth while to incur the expense of a test gun to try his powder with, and partly owing to this fact we find ourselves beaten by the German Company, who not only have a large number of works in Germany and Russia, but who have now established extensive works at Chilworth in Surrey. As a further instance of the greater care shown by our foreign competitors, we learn that the German makers of armour plates also have a large gun and testing grounds, where they test samples of every fresh charge of steel made, by actually firing shot against it. A result is that the makers in question have established a deservedly high reputation for the excellence of their manufacture, and they are able to secure important Government orders. In our opinion this is in no small degree due to the effect of a superior technical education which engenders habits of care, and a keener appreciation of the importance in all cases of accurately testing the results of processes and operations on which success so much depends.

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Whitworth Scholarships.—We learn from the Manchester Technical School that considerable modifications have been made in the rules under which these scholarships are to be awarded in future. In addition to scholarships, a number of exhibitions are established, according to the following scheme: Twenty £100 exhibitions, ten £50 exhibitions, and four scholarships of £125 a year, tenable for three years, will be competed for in 1888; ten £100 exhibitions, twenty £50 exhibitions, and four scholarships of £125, tenable for three years, in 1889; and thirty £50 exhibitions, and four scholarships of £125 a year, tenable for three years, in each subsequent year. The competitors who obtain scholarships of £125 a year will be required while holding their scholarships to devote their time entirely to the prosecution of their education as mechanical engineers, and before any scholarship can be finally awarded, the scholar must state, for the approval of the Department, precisely how he proposes to spend his time during the tenure of the scholarship, and that he will pursue such a course of work or study as is approved or required by the Department. No scholar will be permitted to take any place of profit, or continue in any business he may be engaged in when he obtains his scholarship, except under very exceptional circumstances. No candidate can obtain a Whitworth Scholarship twice, and no Whitworth Scholar is eligible to compete for a Whitworth Exhibition. A copy of the revised rules, issued with the new syllabus, can be obtained at the Manchester Technical School.

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Oxygen of the Air.—It has long been known that the proportion of oxygen in the air varies slightly in different localities, but we now learn from Germany that the result of some recent experiments shows that the extent of the variation is greater than has been hitherto supposed. It appears that Herr W. Hempel arranged for samples of air to be collected simultaneously at Dresden, Bonn, Cleveland, U.S., Para, and Tromsoë. Collections were made daily from 1st April to 16th May of last year, and all the samples were carefully analysed. The mean percentage of oxygen was 20·93, but it was as high as 21·0 on 22nd April at Tromsoe, and as low as 20·86 on 26th April at Para. The averages for all the places of observation were, 20·92 at Para and Bonn, 20·93 at Cleveland and Dresden, and no less than 20·95 at Tromsoë, thus showing that during the period of trial the air was richer in oxygen towards the north.

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The proportion which the nitrogen of the air bears to the total volume of the air remains practically constant, but the proportion of oxygen varies with the amount of carbonic acid and the organic impurities present in the air. If, therefore, the percentage of oxygen is high, it may be assumed that the air is relatively free from impurities, and for this reason Tromsoë may be said to have the purest air of all the places tried. Such a variation in the proportion of oxygen as is here given would of itself have little or no effect physiologically on the human being, but as an index of the comparative freedom from impurities in different places it is of very great importance. We regret to say that the injurious effect of organic impurities in the air is too little understood or thought of by people generally. The subject is, however, one of great importance, and if our theatres, churches, and other places of public resort were more thoroughly ventilated there would be fewer organic impurities, and consequently fewer sufferings from headaches and malaise. It would be very instructive if samples of the air breathed in our public buildings when filled with an audience were systematically collected and analysed, and if some really competent man of science were to take charge of the investigation.

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The Longevity of Working Men.—Those who are familiar with the working of life insurance offices are aware that to a certain extent averages are worked out for the probable duration of lives in different professions, but the *Berliner Zeitung* has made a much more elaborate classification after collecting statistics of the lives of all who are engaged in industrial pursuits in Germany. From these returns it appears that the lifetime of the gardener, the mariner, and the fisherman averages 58 years; that of the baker, the brewer, and the butcher, 54 years; the carpenter, the bricklayer, and the painter, 49; the locksmith, the blacksmith, and the cabinet-maker, 47 years; the shoemaker and the tailor, 44 years; that of the stonemason, the sculptor, the compositor, and the lithographer, 41 years; and the common labourer, 32 years. In the learned professions the following averages are assigned:—The lifetime of ministers of religion is set down at 67 years; that of the schoolmaster at 57; the lawyer at 54; and the physician at 49 years. From this it will be seen that, as might be expected, those who follow their calling in the open air live the longest. The next in order are those who are engaged in the preparation of food, such as the brewer, the baker, and the butcher. Then follow the shoemaker and the tailor, who do not reach a very high standard of old age. After these come the stonemason and the sculptor, and the last is the common labourer, to whom is allotted an average age of only 32 years.

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MEDICAL SCHOOL FOR WOMEN.—The customary inaugural address for the winter session was given this year by Mrs. Scharlieb, M.B., B.S. Lond. Inspired by the recollection of Mr. Ruskin's Seven Lamps of Architecture, she gave as her text "The Seven Lamps of Medicine," which she enumerated as follows:—Obedience, Thoroughness, Truth, Courage, Gentleness, Humility, and Sacrifice. We have here a large share of the cardinal virtues, and Mrs. Scharlieb did quite right to urge medical students to practise them. At the same time we do not quite agree with Mrs. Scharlieb that students of this class are really called on to "surrender the pleasures and enjoyments of youth" or to "renounce their own ways," any more than conscientious students in other walks in life. As a matter of fact, a medical student has to work hard to render himself or herself efficient for future practice, but we cannot forget that a large portion of the knowledge to be acquired is of the most absorbing interest.

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The training for medical work is, or should be, distinctly a scientific one; and it embraces so many branches of science that we are disposed to congratulate rather than condole with a student whose good fortune it is to have the time and money to prepare for such a career. Again, we cannot but dissent from Mrs. Scharlieb's exhortation to "seek no earthly reward." Every labourer is worthy of his hire, and if the practitioner, man or woman, has been properly trained and is capable of doing good work, there should be no dishonour in seeking reward while at the same time doing good to the patient. It would indeed be bordering on false sentiment to treat the question otherwise. We fully appreciate Mrs. Scharlieb's desire to place a high standard before the students she was addressing, but after all the practical side of life has also to be taken account of, and the wherewithal to live has to be found.

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THE BRITISH ASSOCIATION.—All well-wishers of this Association must have noticed with satisfaction that its sectional procedure has been the subject of criticism in several leading journals. We say this in no carping or unfriendly spirit, but from a sincere desire to see beneficial reforms in the direction we have already indicated on several occasions. There can be no manner of doubt that means should be taken to weed out unworthy papers, that those to be read should be more precisely classified, and that no paper should be presented in more than one section. A difficulty there will always be, in preventing a favoured few from obtaining an undue proportion of the time allotted for reading papers on certain subjects. This, however, is not to be overcome by any mere rule, but by the firmness, tact, and impartiality of the president of each section. There has lately been more scoffing than usual at the work of the Association, but its shortcomings are after all not so serious as to be beyond the power of the Executive to remedy, if only the faults are admitted and the true remedies sought. There is happily a growing desire for acquiring and spreading knowledge, and for fifty-six years the British Association has been actively engaged in this direction. Much good it has certainly done, but that is no reason why it should not keep pace with the times, and do more.

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HOW TO ACT AT A FIRE.—In a lecture before the Society of Arts, Mr. A. W. C. Ghean gave the following concise and simple directions how to act on the occurrence of fires. Fire requires air; therefore, on its appearance, every effort should be made to exclude air—shut all doors and windows. By this means fire may be confined to a single room for a sufficient period to allow all the inmates to be aroused and escape; but if the doors and windows are thrown open, the fanning of the wind and the draught will instantly cause the flames to increase with extraordinary rapidity. It must never be forgotten that the most precious moments are at the beginning of a fire, and not a single second of time should be lost in tackling it. In a room a tablecloth can be so used as to smother a large sheet of flame, and a cushion may serve to beat it out; a coat or anything similar may be used with an equally successful result. The great point is presence of mind; calmness in danger, action guided by reason and thought. In all large houses buckets of water should be placed on every landing, a little salt being put in the water. Always endeavour to attack the bed of a fire; if you cannot extinguish a fire, shut the window, and be sure to shut the door when making good your retreat. A wet silk handkerchief tied over the eyes and nose will make breathing possible in the midst of much smoke, and a blanket, wetted and wrapped around the body, will enable a person to pass through a sheet of flame in comparative safety. Should a lady's dress catch fire, let the wearer at once lie down. Rolling may extinguish a fire, but if not, anything (woollen preferred) wrapped tightly round will effect the desired purpose. A burn becomes less painful the moment air is excluded from it. For simple burns, oil or the white of egg can be used. One part of carbolic acid to six parts of olive oil is found to be invaluable in most cases, slight or severe, and the first layer of lint should not be removed until the cure is complete, but saturated by the application of fresh outer layers from time to time. Linen rag, soaked in a mixture of equal parts of lime water and linseed oil, also forms a good dressing. Common whiting is very good, applied wet and continually dampened with a sponge.

MOISTURE PROOF GLUE.—Dissolve sixteen ounces of glue in three pints of skim milk, and if a still stronger glue is wanted, add powdered lime. For marine glue, heat moderately a mixture of indiarubber (one part by weight), mineral naphtha or tar (two parts), and add twenty parts of lac in powder. To use this glue, it must be heated to a temperature of 120° C.—*Revue Industrielle.*

FARMING BY GASLIGHT.—Howard County farmers residing in the vicinity of the great Shrader gas-well, near Kokomo, Indiana, go on record as harvesting the first wheat by natural gaslight. A dozen self-binders and men shocking wheat was truly a novel scene, which was witnessed by hundreds of people who surrounded the fields of grain in carriages. The constant roar of the Shrader well can be distinctly heard eight miles away, while the light can be plainly seen at Burlington, fifteen miles west of here. The estimated flow of gas from this well is 15,000,000 cubic feet every twenty-four hours.—*Indianapolis Journal.*

## GENERAL NOTES.

Preservation of Fruit.—Professor Tyndall has proved that atmospheric germs cannot pass through a layer of cotton, and it is now said that preserved fruit may be kept in perfect condition by covering the jar with cotton batting. Putrefaction is caused by minute atmospheric germs. These are expelled by cooking, and the cotton batting prevents their return when the fruit cools.

New Aluminium Works.—An experimental trial is being made at Tyldesley, by a London syndicate, of Dr. Kleiner's process for the reduction of aluminium by electricity. Plant of sufficient capacity to give the process a fair trial is being put down, and has been principally supplied by Messrs. Mather and Platt, of Salford. It is intended to carry on operations for at least twelve months, and, in the event of successful results being obtained, to put down large works and plant.

Submarine Earth Cooling.—M. Faye, the French astronomer, has drawn attention at a recent meeting of the Paris Academy of Sciences to the apparent geological law that the cooling of the terrestrial crust goes on more rapidly under the sea than with a land surface. Hence, he argues that the crust must thicken under oceans at a more rapid rate, and so gives rise to a swelling-up and distortion of the thinner portions of the crust, in other words, to the formation of mountain chains.

Cloud Thickness and Rain.—In a communication to the London Meteorological Society Captain Toynbee states as his conclusion that clouds of not less than 2,000 feet in thickness are seldom accompanied by rain, or if they are it is very gentle, consisting of minute drops; with thickness of between 2,000 and 4,000 feet the size of the drops is moderate; with increasing thickness of the clouds comes an increasing size of the drops, and at the same time the degree of temperature becomes lowered. When the thickness amounts to more than 6,000 feet hail is produced.

New Dry Plate Competition.—Those who have a turn for experimental work may note that M. Davanne offers a prize of £40 (*i.e.* 1,000 francs) for a new kind of dry plate, which shall combine the advantages possessed by collodion and gelatine films respectively. Great rapidity, ease of manipulation, and simplicity are the three main qualities which the competitors must keep in view. All applications must be sent to Paris before the last day of this year, and must be accompanied by a detailed description of the method of working, together with negatives taken by the process, and prints from the same.—*Camera.*

The Measurement of Lightning.—The length of a flash of lightning is generally under-estimated. The longest known was measured by M. P. Petit, of Toulouse. This flash was ten and a half miles in length. The longest interval ever remarked between the flash and the report was seventy-two seconds, which would correspond with a distance of fourteen miles. Direct researches have shown that a storm is seldom heard at a greater distance than seven to ten miles, while the average are barely heard over four or five miles off. This fact is more curious, as cannon may be distinctly heard double or treble that distance, and in equal cases much better.

The Photogravure Controversy.—Annan and Swan replied in the *Atheneum* to Professor Herkomer's strictures upon photogravure. They contend that photogravure is not the purely mechanical and chemical process which it has been supposed to be, and that it has already done engravers and their art a great deal of good. Messrs. Annan score a point when they say it would have been impossible to have got an engraver for Sir Noel Paton's picture of Oberlin and Titania (reproduced by them in photogravure), on account of the number of figures in it; and Sir Noel himself said that photogravure was the only method by which it could be adequately rendered.—*Photographic News.*

Reassuring.—A contemporary remarks that scientists, as the result of certain plausible and ingenious experiments, have come to the conclusion that the people of London drink polluted water, inhale polluted air, and that their chances of existence are reduced to a minimum. Yet in spite of these depressing speculations, Londoners, instead of meekly affirming scientific truths by dying off-hand, obstinately persist in living and enjoying themselves in their own fashion. Indeed, such is their contrariness that, despite the billions of bacteria in the water they drink and the micro-organisms in the atmosphere they breathe, London is, on the whole, the healthiest large city in the world.

A Steam Balloon.—There is much talk of a steam balloon which is being built by a M. Yon. The form is that of a fish, and its dimensions are gigantic, the length being 200 ft. It is to be enclosed in the usual manner in a net, from which the car will be suspended. The latter will be provided with a rudder and a trapezoidal screw, to be driven by a compact steam engine, weighing 3,740lb. This weight allows 70lb. per i h.p. M. Yon, in an account which he has published of his invention, says that he hopes to attain a speed, in a calm atmosphere, of thirteen or fourteen miles a second. Such a speed would not disgrace one of the inferior members of the planetary system, but, possibly, M. Yon means hours when he talks of seconds.

Scientific Enterprise in America.—The zeal with which the sciences of astronomy and meteorology are pursued in America, and the ingenuity displayed in applying to the purposes of ordinary life the results of the study of those and kindred subjects is striking. As an example, we may mention that, it having been decided by the Signal Service of the United States to abandon a number of the stations on the Pacific Coast, the proprietor of the *San Francisco Chronicle* offered to maintain and conduct those stations at his own expense, on condition that the Government would allow the instruments to remain. The offer has been accepted, and henceforth the *San Francisco Chronicle* will provide observers, and pay for telegrams and warnings.

Steam Tricycle.—A recent number of *La Nature* has an illustrated account of a steam tricycle contrived by MM. Roger de Montais and L'Héritier, which will go 16 to 18 kilometres an hour with one person and 14 to 16 with two. In front is a small boiler heated by petroleum, which gives off, it is said, no smoke nor smell, nor unpleasant heat. Under the seat is the petroleum reservoir, holding ten litres, enough to last ten hours, and behind is a water reservoir which holds thirty-four litres, allowing a two and a half hours' run without fresh supply. This water reservoir has one compartment for cold water, and another for water constantly heated by escape of steam; the latter feeding the vertical engine behind, and the former having steam turned into it at will.

The Great Bell of Cologne.—An official notice has been published of the great bell for the Cathedral of

Cologne, the solemn inauguration of which recently took place with great pomp. The bell weighs 26 tons 13 cwt. The clapper alone weighs nearly 15¾ cwt. Its perpendicular height is almost 14½ feet; its diameter at the mouth nearly 11½ feet. Twenty-two cannons taken from the French were assigned by the Emperor William for its manufacture; 5,000 kilogs. of tin were added. It was cast by Andreas Hamm, of Frankenthal, and 21,000 marks were paid for the casting. It will be known as the Kaiserglocke, or emperor's bell; and as the two other large bells in the cathedral bear the epithets respectively of Pretiosa (precious) and Speciosa (beautiful), this one is styled Gloriosa.—*Horological Journal.*

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EMIN PASHA'S COLLECTION.—An interesting collection of specimens has just been received at the Natural History Branch of the British Museum, Cromwell Road, from Emin Pasha. They were despatched from Wadelai in November last, *viâ* Zanzibar, through the kind assistance of Mr. Mackay, of the Church Missionary Society in Uganda, and have arrived at their destination in good condition. The collection consists of skins of birds and mammals, butterflies, and some anthropological objects, and, when worked out by the officers of the museum, will be described in detail at one of the meetings of the Zoological Society during the ensuing session. In a letter received a few days ago by Professor Flower, dated Wadelai, April 15, Emin Pasha speaks of a further consignment of specimens (chiefly ethnological) as being ready for despatch to the museum on the first opportunity.

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NICKEL STEEL.—Nickel steel is being made by the Ferro-Nickel Society in the following manner:—The plan has reference to a new sort of steel which is said to require no hardening. It is composed of soft iron, nickel, manganese metal or an oxide of it, aluminum, wolfram, and ferro-cyanide of potassium. The steel is produced at one melting. After the iron and nickel are melted the manganese or its oxide and the ferro-cyanide of potassium are added. After a few minutes' time, during which the manganese with the other ingredients are melting and the reaction is taking place, the mass is stirred with a red hot bar of graphite, whereupon the aluminum is added and the stirring for a short time longer is continued. The alloy is to be well melted again, when it can be cast into any decided shape in the usual way, the precaution being observed to paint the moulds with coal tar, free from all water of ammonia, and to have them as free from air as possible.—*Manufacturers' Gazette.*

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AIR ABSORPTION IN CASTINGS.—Great hardness and ductility may be given to red brass without having recourse to phosphor bronze, by mixing in with the other metals a small quantity of green bottle glass. To this end 1 lb. of finely-powdered glass is to be added, say to a 50 lb. crucible charge, or 2 per cent., care being exercised to place the whole quantity of the glass at the bottom of the crucible, whilst the other metals are on the top. The brass obtained is exceedingly hard, and is not easily worked, but the alloy is valuable as a mixture in making other qualities of brass, for which purpose borings, filings, etc., can be used up with advantage. If the above alloy is to be used for parts of machinery and to be tooled, 1 per cent of oxide of manganese should be mixed with the metal to be melted. All sorts of brass made with this alloy are very liquid and close grained. Porous castings become almost an impossibility when the alloy is used, even when cast in green sand. —*Mechanical World.*

THE FIRST LIGHTNING ROD.—If we are to believe an Austrian paper, says *La Lumiere Electrique*, the first lightning rod was not constructed by Franklin, but by a monk of Seuftenberg, in Bohemia, named Prohop Diwisch, who installed an apparatus the 15th of June, 1754, in the garden of the curate of Prenditz (Moravia). The apparatus was composed of a pole, surmounted by an iron rod, supporting twelve curved-up branches, and terminating in as many metallic boxes, filled with iron ore and closed by a boxwood cover, transversed by twenty-seven sharp iron points, which plunged at their base in the ore. All the system was united to the earth by a large chain. The enemies of Diwisch, jealous of his success at the court of Vienna, excited the peasants of the locality against him, and under the pretext that his lightning rod was the cause of the great drought, they made him take down the lightning rod which he had utilised for six years. What is most curious is the form of this first lightning rod, which was of multiple points like the one which M. Melseu afterwards invented.

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MEASURING SUNSHINE.—There are, scattered over various portions of the country, instruments which catch every ray of sunshine falling on them, and write it down indelibly, so that, looking at the picture presented, we may see at a glance whether such and such a day was really fine or cloudy. The contrivance by which this is effected is exceedingly simple, consisting as it does of nothing more than a solid glass ball set on a pedestal with a surrounding frame in which to place at a suitable angle a little strip of blue cardboard, where the effect is seen in a scorched patch of more or less distinctness. As the relative position of the sun changes the scorch changes too, so that at the end of a bright, sunny day the picture on the card consists of a long, scorched line. By measuring this line we get a record of the number of hours sunshine prevalent during the day. The instrument, although commendably simple, has one great drawback: if the brilliancy of the sun's rays is shrouded even to a very small extent by mist, or by a thin veil of cirrus cloud, the heat produced is insufficient to produce a burn on the board.

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BASIC SLAG AS MANURE.—Recent experiments at the Eastern Agricultural Station, the results of which have just been made known, confirm the statements made in Germany and in England, based upon results of similar trials, as to the value of basic slag as a manure. This substance, which contains from 8 to 20 per cent of phosphoric acid, associated with lime, sulphur, and oxides of iron and manganese, has been the subject of much controversy. It was contended by some that slag could be effective only in a state of very fine division, and others feared that the presence of the protoxide of iron would be fatal to its use. The trials at the Eastern Station were undertaken to set these questions at rest. Longwy slag was used in the form of a coarse powder, 3,000 kilo. being distributed over a hectare. The metallic oxide formed about 10 per cent., so that the quantity was 300 kilo. per hectare. The results show that no injury was done to vegetation by the oxide, and that the material is effective when applied as a coarse powder. Hence farmers may safely use from 3,500 to 5,000 kilo. per hectare, according to the richness of the soil. These results are important both to the agricultural and to the iron industries.—*Industries.*

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THE ELECTRIC LIGHT IN A POWDER MILL.—We learn from *Industries* that an interesting electric light installation has just been completed in the Government powder mill in Stein, near Laibach. Hitherto the mill was only run at daylight; but as the demand for powder is unprecedently large, the managers decided to run the mill for the next two years night and day. For this reason artificial lighting became necessary, and on account of the great danger from explosions, no other than the electric light could obviously be used. The work has been carried out by Messrs. B. Egger and Co., of this town, and comprises fifty-one glow and four arc lamps, the latter being two in series and burning parallel with the glow lamps. All the mains, switches, fusible plugs, and branch wires are carried on the outer walls of the building, and the lamps are placed in niches in the walls, the apertures towards the illuminated rooms being guarded by double glass windows with water filling. The niches communicate with the outside by ventilating pipes, which serve as channels for the wires, and keep the temperature low. The dynamo is compound wound, and has an output of 65 ampères at 110 volts; it is driven at 1,000 revolutions by a Girard turbine.

Writing Telegraph.—According to *Nature*, a highly ingenious modification of Cowper's writing telegraph has been shown at the American Exhibition by Mr. J. H. Robertson, an American electrician. The movement of a pen at the sending station varies the resistance of two electric circuits along which two currents are flowing. These varying currents act upon two coils at the receiving station, so as to impart motion in two directions to a pen filled with ink, so that the resultant motion of this pen exactly reproduces the movement of the writing pen at the sending station. Mr. Robertson has replaced Mr. Cowper's resistance coils by a series of thin carbon discs, which vary their resistance with variation of pressure, as was discovered by Edison and utilised in his carbon telephone transmitter. He has also improved the receiving portion, and has made the apparatus very practical. It is being commercially worked out in the United States, and we shall watch its progress with much interest. It forms a really beautiful system of written messages, and is decidedly simpler than any previous system of facsimile telegraphy. It is very doubtful whether there is a demand for such a system, for the operation is necessarily slow.

Match-making.—Nearly all the operations of match-making are now carried on by machinery. The wood is first sawed into blocks of uniform length, usually one and a half inches long, or the length of the match. These blocks are then fed into the cutting-machine, which cuts twelve matches at every stroke. To make round matches, the wood is forced through perforations in metal plates. The slints are then pushed into slats arranged on a double chain 250 feet long. On this they are carried to the sulphur vat, dipped therein by a mechanical movement, and then, in the same manner, to the phosphorous vat and dipped. Machines are also used for making the boxes and packing the slints therein. As the consumption of matches is most enormous —being estimated at six a day for every man, woman, and child in Europe and North America—they form an important article of commerce, and the invention of machinery for their manufacture has proved of great advantage. But the especial value of machinery is that it has so largely reduced the mortality caused by working over the phosphorous. The substance, when heated, throws off fumes which cannot be continuously breathed without causing disease. In large factories 144,000 small boxes of matches are often made and packed ready for shipping in a single day.

Great Engineering Project.—One of the most prodigious engineering projects now on the tapis is that for tunneling the Rocky Mountains under Tray's Peak, which rises no less than 14,441 feet above the level of the sea. It is stated that at 4,441 feet below the peak, by tunneling from east to west for 25,000 feet direct, communication could be opened between the valleys on the Atlantic slope and those on the Pacific side. This would shorten the distance between Denver in Colorado and Salt Lake City, Utah, and consequently the distance between the Missouri River, say at St. Louis and San Francisco, nearly 300 miles, and there would be little more required in the way of ascending or descending or tunneling mountains. Part of the work has already been accomplished. The country from the Missouri to the foot of the Rockies rises gradually in rolling prairie until an elevation is reached of 5,200 feet above the sea level. The Rockies themselves rise at various places to a height exceeding 11,000 feet. Of the twenty most famous passes, only seven are below 10,000 feet, while five are upward of 12,000, and one is 13,000 feet. The point from which it is proposed to tunnel is sixty miles due west from Denver, and, though one of the highest peaks, it is by far the narrowest in the great backbone of the American Continent.

A Development in Newspaper Industry.—We learn from *The Yorkshire Post* that its method for promptly receiving news have been materially added to by the laying down of a pneumatic tube between the offices of *The Yorkshire Post* and the Postal Telegraph Department. Instead of the enormous number of telegrams which are nightly received at their offices being delivered by messengers, they are now shot through the pneumatic tube from the post-office in ten seconds. The tube consists of a lead pipe of 1½-inch bore and about 750 feet long, and extends from the instrument-room of the Postal Telegraph Department to the receiving table in the sub-editor's room, and is encased in a strong cast-iron protecting pipe, which is laid under the pavement, and passes along Park Row, Bond Street, Basinghall Street, and in at the back of the printing-offices. For the purpose of conveying the messages, a small cylindrical vulcanite " carrier," covered with cloth and fitted with a felt flange or pad at one end, so as to completely fill the aperture of the pipe, is provided. When the signal has been received from the post-office that a carrier has been placed in the pipe, a valve is opened at the receiving end, and the air in the tube having been exhausted by a steam-engine, the message speeds on its way at the rate of about seventy feet per second, and is finally delivered upon the receiving table.

Electrification of Air.—According to the *Electrical Review*, Mr. R. Nahrwoldt has made a series of experiments on the gradual loss of electricity of electrified bodies. In an essay published in 1878 the author proved that the discharge takes place by means of the particles of dust suspended in the air. These are electrified and then repelled from the electrifying body. The result of these experiments led Lodge and Von Obermayer to their method of clearing rooms from smoke. Later on, it was shown that a wire of platina made red-hot by electricity electrified the surrounding air, although it was almost free of dust. For this reason Nahrwoldt resumed his experiments. He found that electricity was discharged through a point only in dusty air. He made his experiments in an air-tight glass shade, the sides of which were covered with a thin layer of glycerine. After the dust was precipitated on the sides of the glass through the action of the electricity, the discharge was very slight. As soon as the wire of platina was electrified, and became red-hot, electricity was again discharged through the point. Nahrwoldt concluded that this was due to particles flying from the red-hot wire. This conclusion was proved to be correct by the occurrence of platina in the deposits on the sides, and by the loss of weight of the wire. These experiments led him to the conclusion that air free of dust cannot be electrified statically.

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PHOTOGRAPHIC SCHOOLS IN AUSTRIA AND GERMANY.—More and more attention is given in this country to the fact that a scientific education of those young men who intend to embrace photography as a profession becomes a necessity. In a few months there will be opened at Vienna, under the direction of the eminent professor Eder, a photographic school, in which instruction will be given in all photographic and photo-mechanical processes. There is no doubt this newly established school will do much good to the young professional photographer who has visited it; the education received will guide him in his professional duty, and establish his social standing. Also at the technical academy of Karlsruhe (Baden) instruction will be given in photography from this month forward. Herr Fritz Schmidt, of Breslau, the well known teacher of scientific photography, has been appointed as professor, and according to the programme, he intends to instruct in photography—collotype (lichtdruck), and kindred processes—with regard to its scientific, technical, and artistic application. Besides this there has been for many years a photographic private school at Grönenbach, Bavaria, the proprietor of which is the well deserving photographer and collotyper, W. Cronenberg. In this establishment, beautifully situated in the midst of pleasant meadows, and in the sight of the Bavarian Alps, hundreds of scholars of all countries have received a most careful instruction in all branches of the old and new photographic process.—*Photographic News.*

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PROTECTING IRON AGAINST RUST.—*La Metallurgie* describes a metallic compound for the protection of iron, consisting of a solution of aluminium in palmitic acid. A product is thereby obtained which has the property of dissolving zinc in large quantities. In this manner an alloy of aluminium and zinc is produced which costs but little, as only a small quantity of aluminium is present. This is applied with a brush to the iron, which is thus effectually protected against oxidation. The *Illustrirte Zeitung für Blechindustrie* quotes a communication on the above subject from Herr Busse, of Hanover, who states that some years ago he pointed out that bright iron and steel articles could be successfully protected by super-oxidised linoleine acid against the formation of rust, without any injury to their metallic lustre. It is remarked that a simple and efficacious preventive of rust must necessarily be welcome in most workshops, as after a great deal of trouble has been taken in producing a brilliant polish, a small quantity of moisture produces oxidation. The hydrate of linoleine acid is as elastic as indiarubber, and its wine-yellow syrupy solution, when thinly applied to metallic objects, forms a transparent, hardening, elastic, and extensible layer which prevents oxidation. The bright portions of ironwork have first to be cleaned with a woollen rag from grease, dirt, and damp; the rust-preventing solution being then thinly applied with a soft brush. By careful treatment the metal surfaces lose none of their brightness, and on account of the elasticity of the composition, it does not crack if the metal is bent or becomes extended.

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AN ELECTRIC BOY.—An American journal gives the following account of the "electrical boy" mystery: Johnny Norton, who a few years ago was well known all over the country as Bunnell's "electric boy," is now working in this city as a compositor. In reply to the query of reporter as to what had become of his electricity, he said: "When I was on exhibition I was enclosed in an oblong stall about seven or eight feet long, the front of which was like a narrow counter. Opposite the counter was a rail which only allowed the visitors to pass in single file. A long strip of cocoa matting served as a carpet for the passage-way and also for a cover for a sheet of zinc, which extended beneath it, running the length of the stall. My box was similarly invested with zinc and matting. Attached to the sheets of metal, but hidden from view, were the two poles of a galvanic battery, one under my feet and the other in the passage. Now, anyone passing over the zinc and touching me behind the counter, completed the circut and received a shock. So did I. The matting, of course, had to be kept damp, water being the conductor. It was surprising what intelligent people were duped by this trick. Why, I was kept shaking hands and being fingered from morning until night. Many is the two-dollar note I received from doctors and others for a couple of drops of my blood for analysis. One evening three or four young students came in to unmask me. One of them made a wager that he would electrify the audience the same way if he was in the box. I immediately invited him in and he accepted the challenge. I then retired, but before doing so I pressed a hidden button that cut off my wire. He, of course, failed and ignominiously retreated, after being guyed unmercifully by those present. This proved me genuine to the satisfaction of everyone in that town, and I became famous. There was a lot of fun in the business; but I had to give it up, as the constant strain caused by the battery was too much for me."

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CURIOSITIES UNDER THE SEA.—As to the quantity of light at the bottom of the sea, there has been much dispute. Animals dredged from below 700 fathoms either have no eyes or faint indications of them, or else their eyes are very large and protruding. Another strange thing is that if the creatures in those lower depths have any colour, it is orange or red or reddish-orange. Sea anemones, corals, shrimps, and crabs all have this brilliant colour. Sometimes it is pure red or scarlet, and in many specimens it inclines towards purple. Not a green or blue fish is found. The orange-red is the fish's protection; for the bluish-green light in the bottom of the ocean makes the orange or red fish appear of a neutral tint, and hides it from its enemies. Many animals are black, others neutral in colour. Some fish are provided with boring tails, so that they can burrow in the mud. Finally, the surface of the submarine mountain is covered with shells like an ordinary sea beach, showing that it is the eating-house of vast shoals of carnivorous animals. A codfish takes a whole oyster in his mouth, cracks the shell, and sucks out the meat. In that way come whole mounds of shells that are dredged up. Not a fish bone was ever dredged up. A piece of wood may be dredged up once a year, but it is honeycombed by the boring shellfish, and falls to pieces at the touch of the hand. This shows what destruction is constantly going on in these depths. If a ship sinks at sea with all on board, it would be eaten by fish, with the exception of the metal, which would corrode and disappear. Not a bone of a human body would remain after a few days. It is a constant display of the law of survival of the fittest. Nothing made by the hand of man was dredged up after cruising for months in the track of ocean vessels excepting coal clinkers shovelled overboard from steamships, but twenty-five miles from land there was dredged up an india-rubber doll. This was one thing the fish could not eat.—*Liverpool Echo.*

## THE UTILISATION OF REFUSE.

THE theoretical condition in every manufacturing process is, that every article taken in hand should issue from the works in a useful, and therefore, saleable state. In most cases, however, there is a fairly wide margin between this ideal state of things, and that which hitherto has been reached in actual practice. This margin is waste or refuse, and means diminished profit to the manufacturer, indirect loss to the community, and sometimes, in addition, a nuisance actual or potential. Hence there exists among inventors a very natural and laudable desire to reduce this source of loss, either by preventing the refuse from ever being formed, or, if formed, by turning it to some account. In many instances these attempts have been successful, and it may be said that millions have been thus gained by the utilisation of matter heretofore a mere encumbrance. Entire new branches of industry have thus sprung up. But there is one grave difficulty always in the way; any manufacture which takes as its raw material the refuse of some other manufacture may find itself suddenly stranded, if, in consequence of some improvement, it is turned out only in very restricted quantities.

Thus at present hydrochloric acid is, if not a refuse, yet a bye-product of the alkali manufacture on the Leblanc system. On a plentiful and consequently cheap supply of this acid depends the production of chloride of lime, the mainstay of the bleacher's business. But it seems not unlikely that the Leblanc process will be superseded by the Solvay process, in which hydrochloric acid, if produced at all, will not be turned out incidentally as a waste product seeking application. In that case it would have to be made specially, and its price would necessarily rise. The cost of chloride of lime would then rise, and the bleaching both of linen, cotton, and paper, would become more expensive.

As an instance of a waste product which has entirely disappeared, may be mentioned the solution of chloride of manganese from the chlorine stills. This liquid was at one time to be had for fetching away, and was useful, amongst other purposes, for the treatment of sewage, and for disinfection generally. But since the great improvement in the manufacture of chlorine, for which the world is indebted to the late Mr. Weldon, this refuse is no longer produced. The manganese from the stills is regenerated, and can be used over and over again. Hence, those who want chloride of manganese for any purpose can no longer obtain it as a waste product, but must make it especially at a higher cost.

The iron manufacture throws off an enormous quantity of refuse in the form of slag. To such an extent is this waste produced, that some iron-masters have even been under the necessity of renting large plots of land to receive it. Of course, many attempts have been made for its utilisation, and not without success; but none of them consumes anything like the quantity which, in one way or other, has to be got rid of. In some parts of England and Scotland, it is used as a material for making and mending roads. The huge blocks of slag, still very hot, are conveyed away in iron-carts, and laid by the roadside until sufficiently cool to be further dealt with. In the neighbourhood of Brighouse, Bradford, etc., it is common to see boys roasting potatoes by laying them on the hot masses.

It has been proposed to cast the slag into blocks about the size of bricks, and to use them as a building material. But as far as dwelling-houses, work-rooms, etc., are concerned this project was found impracticable, owing to a difficulty mentioned in the article on ventilation in our June number. Slag-bricks may serve for the inclosing-walls of court-yards, etc., but this does not create by any means a sufficient demand.

Another and more successful attempt has been made by Mr. Bashley Britten at Finedon, in Northamptonshire. He takes the molten slag as it runs from the furnaces, and converts it into glass by the addition of a suitable proportion of silica (sand) and alkali. It is essential for this process that the glass works should be very close to the blast furnaces. In this manner not only is the cost of carriage, loading and unloading saved, but the heat of the slag is utilised, and thus a great economy of fuel is obtained. If the slag were first allowed to solidify before being run into the tank of the Siemens' furnace and mixed with the other ingredients, its use would scarcely be remunerative.

Some quantity of slag is consumed in the manufacture of the so-called slag-wool. Whilst in a molten state it is brought in contact in a thin stream with a current of superheated steam, and is by this means converted into a mass of filaments or fibres, somewhat resembling coarse wool in appearance. The value of this material lies in its being a very poor conductor of heat. Hence slag-wool may serve as a covering for steam-boilers, steam-pipes, and pipes conveying hot liquids which have to be protected from cooling. This use would secure for slag-wool a very considerable demand if there were no rival in the field. But asbestos or amianthus, a natural mineral which occurs in fine fibres, almost silky masses, answers all the purposes to which slag-wool can be put at least as well, and as it is found in abundance in many parts of the world, the future of slag-wool appears doubtful.

It has also been proposed to utilise ordinary blast-furnace slags in the manufacture of alum, alum cake, and other preparations of alumina. For this purpose the slag, as it issues from the furnace, is allowed to fall into a tank of cold water. It is thus resolved into a powder, and is then easily acted upon by acids. For preparing cheap, crude sulphate or chloride of alumina for sanitary purposes, the treatment of sewage, etc., this process answers admirably. But for the manufacture of fine alum for the use of the dyer and calico-printer, it is not yet proved that this method presents any advantage over the ordinary processes, where bauxite, cryolite, or china-clay serves as the raw material.

So far, then, the projects for the utilisation of iron-slags fall far short of keeping up with the supply of a refuse which is accumulating at the rate of 8,000 tons yearly. But a change is occurring wherever the so-called "basic process" of Thomas and Gilchrist is found applicable to the ores smelted. The slag produced in this case is quite different in its composition from the slags of the old process, and is applicable to quite different uses. It contains from fourteen to twenty per cent. of phosphoric acid, according to the different qualities of ore worked upon. Hence if ground to powder it has a great agricultural value, and is already used by farmers to an enormous extent. This sale and use naturally interferes with the superphosphate trade. A percentage of phosphoric acid in the Thomas slag, being a refuse product, can, of course, be offered at a lower figure than a percentage of the same acid in the form of superphosphate, bone-manure, etc., which has to be specially manufactured. Hence a serious blow has been given to the chemical manure-maker, and to all persons employed in mining for apatite, phosphorite, coprolites, or any other phosphatic minerals. This is an instructive example how an improvement in some branch of industry may derange and even paralyse some other branch, with which it does not seem at all to come in contact.

But some Thomas slags contain another material which has lately become of technical importance. This is vanadium, a metal which until lately was known only as a chemical curiosity, and which in a pure state was valued at upwards of 1s. per grain! It proves, however, to be better adapted for getting up aniline blacks upon cotton goods than any other substance known, whilst an almost infinitesimal quantity is sufficient to produce the desired colour. Now in the Thomas slag, as turned out at the Creusôt iron-works in France, vanadium is found at the rate of one quarter per cent. As the other substances present do not in the least interfere, a simple solution of the slag in hydrochloric acid answers the purpose without the somewhat tedious and expensive process of separating out the vanadium in a state of purity. Thus we see that an improvement in the iron manufacture confers quite unforeseen benefits upon the calico-printer.

Among the declining manufactures of the day may be mentioned potassium ferrocyanide, more familiarly known as prussiate of potash. Its main uses were in dyeing certain blues on textile goods, and in the manufacture of prussian blue. But prussian blue as a pigment has been almost superseded by artificial ultramarine, which is cheaper and more beautiful, though far less permanent. Meantime, also, the prussian blues and royal blues on cotton and woollen goods, and still more on silks, are almost abandoned in favour of the aniline blues, which are not only finer but much more easily dyed. Hence the production of prussiate of potash has declined to very small quantities. Its chief residual product was a kind of carbon which, being derived from animal matter, was in fact an animal charcoal, and possessed similar properties, though it was to be had at a mere fraction of the price of bone-black. Hence it served for sanitary purposes. Now it is scarcely procurable, and those who employed it have to look out elsewhere. It is a fortunate circumstance that this carbon did not become the basis of any important manufacture.

We spoke above of the alkali manufacture by the Leblanc process, and of one of its by-products. But this process leaves great quantities of a refuse of a very undesirable nature, known as vat waste, tank waste, or alkali waste. In districts where the alkali manufacture flourishes are to be seen huge heaps of this refuse giving off offensive fumes and proving a nuisance wherever it is put. It has been tried as a manure with the effect of rendering the land barren for years. It can be used in the manufacture of hyposulphite of soda, a substance much used in photography. But all the consumption required for this purpose did not perceptibly affect the extensive heaps of waste.

Some very ingenious processes were devised for extracting the sulphur, which this waste contains in large proportion, so that it may be used over again in the manufacture of sulphuric acid. Three of these processes are actually in use, and a certain proportion of the sulphur is profitably recovered. Still it can scarcely be denied that there is room for further ingenuity in this direction.

The woollen manufacture is unpleasantly notorious for the quantity of refuse which it produces. It is asserted that for every ton of cloth which leaves a manufactory for the market, there are turned out two tons of refuse, serving mainly to pollute the streams. Of these, however, one of the most important and unsightly, to wit, the soap-suds from cleansing the wool and from fulling the cloth are now arrested in catch-pits. When a sufficient quantity is thus collected, it is treated with sulphuric acid, which causes the fatty matter to separate out and rise in cakes to the surface. It is withdrawn, washed, purified to some extent, and may then serve for the manufacture of lubricants or for soaps of a low quality. The soda, ammoniacal liquor, and urine used in scouring the wool have hitherto utterly run to waste, nor, according to our present knowledge, does their utilisation seem probable. The same must be confessed of the coloured liquids obtained on rinsing the wool, the yarns, or pieces, after dyeing. They contain but a very minute quantity of different colouring matters mixed together and diffused through a great bulk of water. No attempt to separate them from it and from each other has hitherto proved remunerative.

Spent dye-woods and waste tan have been proposed as materials for the manufacture of acetic and of oxalic acids. Hitherto the results have not been very encouraging, and now both these kinds of refuse, after drying, are burnt in the engine furnace. There is here, therefore, room for a better method of utilisation.

We may conclude this brief sketch of the purposes to which industrial refuse has been or may be put, with a glance at the most splendid instance of its utilisation. The extraction of beautiful dyes, and latterly of medicines, from coal tar has so often served to "point a moral and adorn a tale" that it may well pall on the reader's ear. Liebig, now many years ago, said that we might obtain from coal-tar whatever we wished if we only knew rightly how to search for it. He did not say, however, that we could always obtain it remuneratively. Of the commercial failure of such an attempt the artificial production of indigo has been a warning example. It is also instructive that the manufacturers of coal-tar products often find themselves now unable to offer for the tar a price which gas producers think remunerative. Hence, not a few gas-managers have been, as of old, studying the results of its use as fuel under their retorts.

One great difficulty which besets all attempts at the utilisation of refuse—and which has particularly pressed on the tar industry—is that the raw material cannot be bought in an open market, but must be contracted for. Now, in view of the sudden changes which occur, it may be said that no manufacture thus situated is in a safe or a healthy position.

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## EDISON'S NEW LABORATORY.

FROM the *Scientific American* we have made the following extracts from a description of Mr. Edison's new laboratory, now being built at Orange, New Jersey :—

"Not more than half a mile from Mr. Edison's residence are the foundations and rapidly-rising walls of five large buildings, which, when completed and furnished, will constitute his laboratory. It will probably be the largest and most complete private laboratory in the world. Orders have been placed for the physical and chemical apparatus with the best makers in America and Europe. The finest machinery for all uses has been ordered, and will soon be in place. No purely historic apparatus or machinery has been purchased. Everything will be on a practical basis. The range of the laboratory will be extremely wide and diversified. Any experiment relating to anything of which we have any knowledge may here be tried speedily and with all possible precision. The laboratory is exclusively for Mr. Edison's own use, and will be wholly applied to perfecting his inventions and putting them in commercial form.

"The main building of the laboratory is 250 feet long, 50 feet wide, and two stories high. It will contain on the lower floor a complete machine-shop, and upon the second floor of the main building there will be a grinding and polishing department. Upon this floor there will also be a room devoted to photography, another devoted to drawing, and another to machinery and instruments of precision. There will be three experiment-rooms, in which apparatus made in other parts of the laboratory will be experimented with and perfected. Upon this floor the power will be distributed by electricity, a motor being placed at each machine. In each experiment-room there will be a table provided with pipes for supplying city gas, fuel gas, compressed air, cold water, hot water, steam, and hydrogen. There will also be here, as elsewhere throughout the entire laboratory, wires for conveying electric currents.

"The top floor of the main building is devoted mostly to fine apparatus. There will be thirty-four cases for such apparatus, each 2 ft. 4 in. wide and 21 ft. long. There will be about 18,000 dols. worth of apparatus of this sort in this department. The apparatus has been ordered from such makers as Edlemann, Hartman and Brauhn, Lattimer, Clark and Muirhead, Siemens Bros., Carpentier, Société Genevoise, and, in fact, from all the principal makers. Among the apparatus there will be a large Ruhmkorff coil, a Dubosc phosphoroscope, a Foucault photometer and heliostat, and photometric apparatus of every variety; spectroscopes, and Sir William Thomson's absolute electrometer and quadrant electrometer; a telescope having an Alvan Clark objective, and provided with a Young spectroscope, the telescope being mounted equatorially by Fauth; a spectrometer costing 1,200 dols., a micrometer costing 200 dols., and a Fauth chronograph. Upon the upper floor there will also be a room for projection, 50 ft. by 40 ft. and 16 ft. high. A lantern is being made which will utilise the light of a 5,000 candle arc lamp. Upon this floor there will also be a pump-room for lamp experiments, a glass-blower's room, and a room for jeweller's work. In the way of mechanics, the laboratory will be able to produce any kind of machine varying in size from that of a locomotive to that of a watch. The main building will contain a large scientific library.

"In addition to the main building and its annex, there are four buildings each 25 ft. wide, 100 ft. long, and 16 ft. high. In one of these buildings, which is devoted to galvanometers, the use of iron has been carefully avoided, the nails being copper and brass, the tubes lead and copper, and the hinges, locks, window-fasteners, etc., all being of non-magnetic material. In the galvanometer building there will be seven piers of solid stone, entirely detached from the walls of the building, each being provided with a slate top, having a covering of vulcanized hard rubber one inch thick. There will also be two large piers on a level with the floor, 15 ft. long and 8 ft. wide. The apparatus used in this room will be devoted to all kinds of electrical and magnetic testing.

"The second of the smaller buildings will contain a complete chemical laboratory, a balance and spectroscopic-room, an analytical-room, and a room for general experimental work. One-half of the third building will be used as a carpenter's shop, cabinet-making and pattern-shop. The balance of this building will be used for the storage of chemicals.

"The fourth building will be devoted to metallurgy. It will contain a five-stamp mill, a Blake crusher, a 6,000 ampere dynamo, and furnaces of various kinds. It will be supplied with fuel gas from a forty-barrel gasoline gas-producing machine."

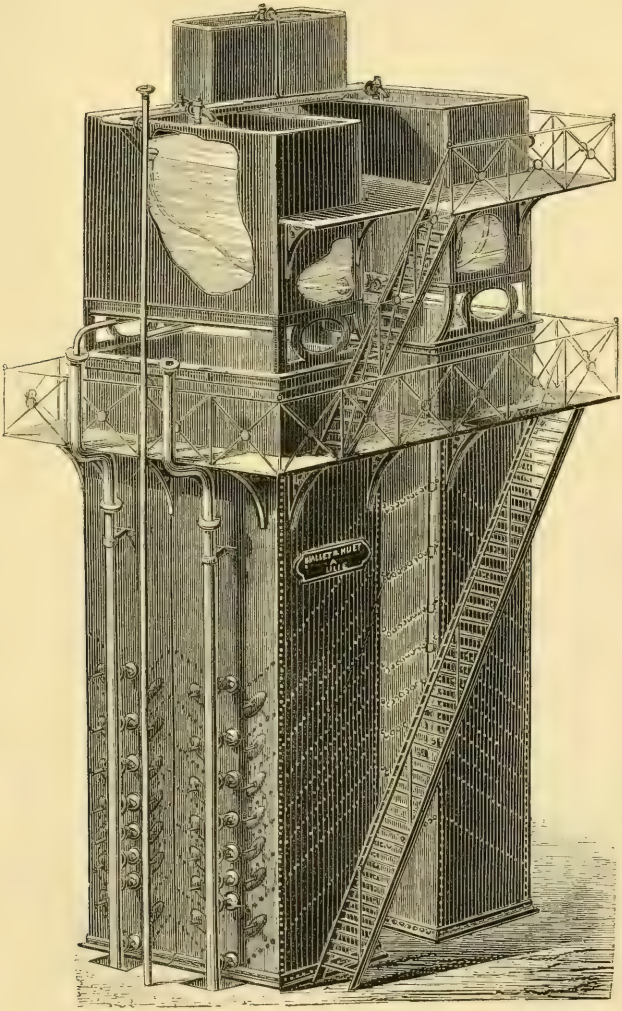
## NEW METHOD OF PRESERVING BUTTER.

M. PIERRE GROSFILS has communicated to the Société d'Encouragement de Vervier a note on his process for preserving butter. After having enumerated the causes which last year led to the lowering of the prices of dairy produce, and especially of butter, he dwells upon the unfortunate results of the over-production of this article, and on its adulteration by means of oleomargarine. He has discovered a way of preserving butter, without alteration, for a long period, so that it can be imported into countries, the climate of which does not permit of it to be made there. The process has been subjected to practical experiments for more than six months. M. Grosfils describes the various phases of his research as follows:—He first mingled a gramme of salicylic acid with a kilogramme of butter, but after some weeks the product had altered. He fancied that the cessation of the antiseptic action of the acid was due to its crystallisation in the non-liquid substances which were mingled with it. After numerous experiments he discovered that lactic has the property of impeding this crystallisation. This acid is, in fact, a tolerably powerful solvent of the salicylic acid; and to prevent the crystallisation of the salicylic acid is to maintain indefinitely the antiseptic power of the product. The first result of the discovery of M. Grosfils was to be able to sensibly diminish the amount of salicylic acid used to preserve the butter. Instead of mixing one gramme of acid per kilogramme, he put the butter in a liquid containing 0·5 per cent. of salicylic acid and 3 per cent. of lactic acid. He afterwards divided the salicylic acid into still smaller doses, until at last he had the proportion of one gramme of acid to 5,000 parts of water. This composition allows of the indefinite preservation of butter of good quality, even in hot countries. If the butter has already undergone some alteration, a stronger dose must be used. The author, however, points out the following important matter:—The lactic acid contained in the antiseptic liquid in doses stronger than 2 per cent. gives the product a taste which, without being offensive, is a little too sour to enable the article to be sold. In such cases the butter should be washed with water, or, better still, with scalded milk, to which a little carbonate of soda has been added to prevent coagulation of the caseine. This washing will not only remove the lactic acid and its taste, but also the salicylic acid in solution, to such a degree that what remains will be imperceptible. The process is stated to be most economical, as the antiseptic liquid will serve indefinitely, being unalterable. Care must be taken each time to use the same quantity of butter. The preparation of a kilogramme of butter by means of this process will not cost more than one or two centimes.—*Moniteur Industriel.*

CURIOUS EFFECTS OF LIGHTNING.—The steamship *Anchoria,* of the Anchor line, which lately arrived in New York, met a tornado 180 miles from Sandy Hook. The wind came from the north-east, and in a very short time there was a tremendous sea running. The rain came down in such torrents that the crew were scarcely able to stand upon deck. The lightning poured in streams of a minute's duration from the clouds to the water, while globes of blue flame played up and down the rigging and danced along the yards, and leaped from the masts incessantly, terrifying passengers and seamen alike. The steamship *Glenartney,* from Shanghai, was in the same storm, and had well-defined tufts of electric fire on each mast-head. The other day Charles M. Lee, a cowboy, and his horse were struck by lightning, which killed them both, near Cheyenne Wells, Col. The stroke broke the iron horn of the saddle, exploded all the cartridges in his belt, and set fire to the leather of the saddle, picket rope, blanket; tearing his hat, boots, and shirt to pieces, and the fire consumed the flesh of the left leg from the knee to the ankle. In Cape Colony, South Africa, a shepherd drove a flock of 1,430 ewes up to a small building, in which he took refuge from a thunderstorm. As the sheep crowded around the building it was struck by lightning, and 790 of them were killed outright. The shepherd escaped with a severe shock.—*Scientific American.*

## SOFTENING WATER.

IN our last number (p. 179) we described an apparatus made by the Stanhope Company for softening water by means of soda and lime. The accompanying illustration shows an apparatus identically the same in principle, but of a larger size, there being two clarifying vessels instead of one. As already mentioned, the water to be softened enters the large external pipe shown in the figure, a proper proportion of the chemical re-agents (soda and lime-water) being admitted at the same time. The mixture in the pipe then enters the bottom of one of the clarifying vessels, the other being merely a duplicate, and having precisely similar connections. The water in the clarifying vessels rises slowly, and the precipitates formed are deposited on the inclined trays shown in dotted lines. When the water reaches the top of the vessels it is quite clear and fit for use.



THE STANHOPE WATER SOFTENER, WITH DOUBLE CLARIFYING VESSELS.

## THE TELEPHONE: ITS PRINCIPLES, CONSTRUCTION, & APPLICATION.

IV.

A MISTAKE occurs in the table of cycle of actions at the end of the last article (page 182), which makes the table somewhat obscure. The three headings in italics, which mark the divisions between the electrical and the mechanical portions of the cycle should read, "*Mechanical Operations*," "*Electrical Operations*," "*Mechanical Operations*"—and the word "operations" standing between "variations of current," and "strength resulting in" should be omitted; the sentence then reading, "And consequent variations of current strength resulting in variable magnetisation," etc.

Many good instruments have been invented, and are more or less in use, which mostly differ in details only from those which have been looked at. The Edison loud-speaking receiver, which is based upon a quite different law to any other, demands a few words. Edison discovered that a metal wire or style, resting upon a damp, moving surface, such as the chemical paper of the Bain telegraph iustrument, had a smaller dragging stress communicated to it when a current passed from the style to the moist surface, and that, if mounted on a pivot, with a spring acting upon it against the drag of the paper, it will slip back every time a current passes. The reason is that, when the current passes, the liquid is decomposed, and a little film of gas is formed between the metal and the paper, reducing the friction. As the amount of gas is proportional to the strength of the current, the decrease in the friction varies with the current. This action is an exceedingly sensitive one, and Edison patented it for telegraphic use before the telephone had made any practical appearance.

As soon as the Bell telephone came out, Edison saw the possibiiity of adapting his discovery, and patented a telephone, in which the damp paper of the telegraph instrument was replaced by a revolving cylinder of damp chalk, and the style was attached to a telephone diaphragm. This instrument is the loudest speaking telephone in use, but is rarely employed, as the clockwork necessary for revolving the cylinder, and the necessity for keeping it in a uniformly moist condition, make it a rather troublesome piece of apparatus to keep in order. For lecture demonstrations, such as making a distant musical performance audible all over a large room, it is very effective, and it owes its loud-speaking power to the fact that the energy given to the diaphragm is derived from the clockwork, and may be therefore much greater than the electrical energy, which acts as a controlling force only. The Edison receiver bears much the same relation to the Bell receiver that a variable resistance transmitter bears to the Bell receiver.

The main principles underlying the action of telephones and some practical forms of instruments having been described in the preceding articles, some of the chief practical adaptations of the telephone remain for description.

As these adaptations are mainly dependent upon details of a technical nature, only a general description of the more prominent arrangements can be given here.

For the simplest use of the telephone as a means of communication between two fixed points, it is obvious that it is necessary to have at each end of the line a transmitter and a receiver and some means of calling attention, as the telephone itself is not sufficiently loud for that purpose. The calling arrangement is usually an electric bell of some description, and a key and battery to work the bell; or it may be a small magneto-electric machine in place of the battery. The magneto-electric machine is really a small dynamo, worked by a handle, and giving off an alternating current. The bell used with magneto machines is a special form, having a magnetised armature, which is alternately attracted and repelled by the electro-magnet, through which the alternating currents passes, and causes a little hammer mounted on it to strike two bells in rapid succession. The magneto bell instrument is better than the battery bell, as it reduces the number of batteries to be maintained, gives a louder ring, and rings through far longer lines than any moderate sized battery can operate. Some very lazy people, however, object so the slight trouble of turning the handle, and insist on having the battery form of instrument.

Some form of switch has to be used to connect the line either to the bell or the speaking apparatus. If microphone transmitters are in use, the switch must also put the battery in circuit wlth the primary wire of the induction coil when in the speaking position, and cut it off when in the ringing position. This action is necessary to prevent the battery wearing out rapidly, as it would if constantly "short-circuited," through the low resistance of the transmitter and the primary wire of the induction coil. When the apparatus is not in use, the switch is in the "ringing" position, so that the bell is in circuit, and a call can be received.

The switch is usually worked by the weight of the receiving instrument, which, when not in use, is hung on a hook, and so pulls the switch into the "ringing" position. When the telephone is lifted off the hook, a spring pulls the switch into the "speaking" position. In this way the operation of the instrument is made as nearly automatic as possible, with a view, of course, to its being readily used by unskilled persons. On a simple telephone line, fitted in the manner described, and working between two places, A and B, if A wants to speak to B, he rings the latter's bell by means of the push or the magneto handle. B, on hearing the call, responds by a similar action, lifts his receiver off the hook, and applying it to his ear, awaits A's communication. A, on receiving notice of

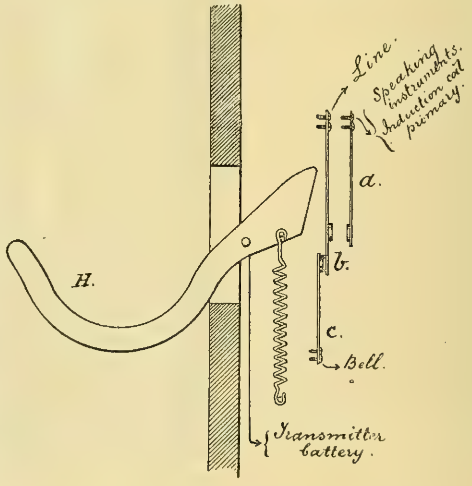



Fig. 13. Ringing Position—Telephone Receiver on Hook.

B's attention by his own bell ringing, lifts his receiver off its hook, and speaks into the transmitter; the required conversation follows, and at its close both parties hang up their receivers, and thereby again put into the line-circuit the calling apparatus ready for the next occasion. Figs. 13 and 14 represent diagrammatically an arrangement which makes the necessary connections on lifting the receiver off or putting it on the hook. Both positions are shown; the lettering of the parts being identical in each. H is a brass

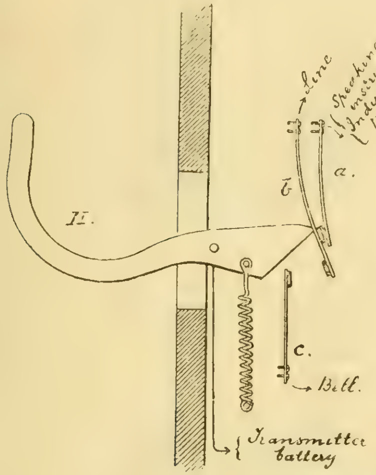



Fig. 14. Speaking Position—Telephone Receiver off Hook.

hook, projecting through the side of the case, pivoted inside, and having a spiral spring attached, which, when the weight of the receiver is off the hook, pulls it into the "speaking" position. The inner end of the hook is a kind of cam, and it is connected to one pole of the battery in the transmitter circuit. In the ringing position, the spring B, connected to the line-wire, presses against the spring C, and is connected through it to the bell and ringing-key or magneto. The spring A, leading to the receiver and the secondary wire of the induction coil, is disconnected and out of circuit, and the primary wire and battery are also disconnected. In this position of the switch it will be seen that a current from the line will pass through the bell-coils, and therefore make the bell ring; or if the ringing-key or magneto is worked, the current from it will go to the line. In the "speaking" position the spring B is pressed against the spring A, and the line is thus connected to the secondary wire and the telephone receiver; the circuit containing the primary wire of the induction coil, the battery, and the transmitter is also closed, and thus any current from the line will pass through the receiver, and any current induced in the secondary wire will pass out to line, and to the distant receiver.

Several other forms of automatic switch are in use, performing the same operations in other ways. That illustrated is practically the one used with the Blake-Bell combination instrument; in the Gower-Bell instrumeut used by the Post Office, two receiving tubes are used, the receiver being fixed in the case, and a length of flexible tube held to each ear. When the instrument is not in use, the tubes hang in hooks on each side of the instrument, and so operate two switches, one of which connects the line to the bell or receiver, while the other closes the transmitter circuit, the two switches thus performing together the same functions as the one switch in the Bell-Blake instrument. The connections are shown in Fig. 15. K is the ringing key, S the switches, the right-hand switch completing the transmitter

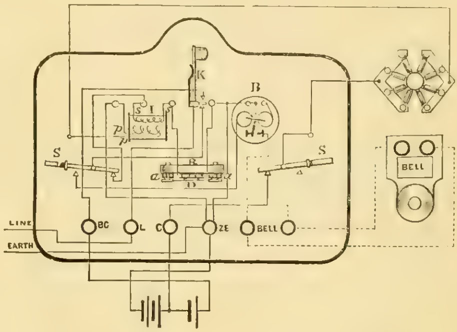



Fig. 15. Connections of Bell-Blake Instrument.

circuit, the left-hand one putting the line into connection with either the bell or the speaking instruments. I is the induction coil, P and S being the primary and secondary wires, and D is the receiver; B is a relay which completes the bell circuit when a current passes through it, the bell being actually rung by one cell of the battery. This arrangement is used for long circuits, on which the battery current is too weak to ring the bell direct. On short lines the relay is not wanted, and the bell-coils are connected in its place. Fig. 16 shows a perspective view of the instrument with the cover removed. This view does not show

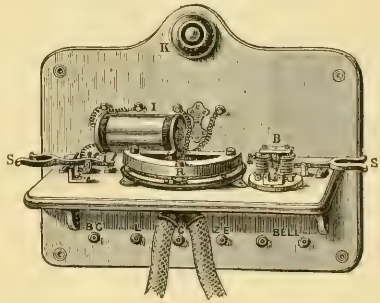



Fig. 16. Perspective View of Bell-Blake Instrument with the cover removed.

the microphone, which is fitted to the underside of the cover. Its form is shown in Fig. 15, on the right, and the details have been already illustrated in Fig. 10 (page 181).

## TECHNICAL EDUCATION ABROAD.

THE question of Technical Education has been stirring the United States, and under the home rule system of local or state government, with what may be termed Imperial control on sharply defined lines at Washington, the lead in such education may soon pass, if it has not already passed, from Germany, sustained as it is by the forces of emulation in the younger states and by those of rivalry in the older. Information scattered over so wide a field as the United States is necessarily troublesome to get together, and it may be the case that the need for this trouble accounts for the little that is known among ourselves of what is actually taking place there. Then, when once American inquiry has been set on foot, and returns have been received, these latter will present more or less of a mixing up of the work of technical schools with what properly belongs to manual training. In time this confusion will disappear, when doubtless the information will be sought after eagerly as partaking of the attractive, general character of things American. The Empire State of New York furnishes a mass of information both on manual training and on technical schools.

Perhaps the best example of the New York State manual training system is afforded by the Worcester Free Institute. This Institute came into existence in 1865 under the provisions of a gift by Mr. John Boynton, and it has since been aided by donations and endowments. Mr. Boynton's wishes were set forth in the following words:—"The aim of the school shall ever be the instruction of youth in those branches of education, not usually taught in the public schools, which are essential, and best adapted to train the young for practical life." In pursuance of these wishes the managers and faculty adopted this as their rule of government:—"This Institute offers a good education—based on the mathematics, living languages, physical science, and drawing—and sufficient practical familiarity with some applied science, to secure the graduate a livelihood. It is specially designed to meet the wants of those who seek to be prepared as mechanics, civil engineers, chemists, or designers, for the duties of their respective professions." The Institute was opened in the autumn of 1868, and the first class graduated in 1871. Fourteen other classes have since graduated, giving up to the close of last year a total of 313 graduates, 295 of whom are now living. About 400 other students, who did not graduate, have attended such classes as they saw fit, and have done good work then and since. Of the graduates, fifty or more were residents of other States or foreign countries; and of 240, nearly 150 are at work in the State of New York, "constituting most valuable and important factors in our industrial pursuits." They are designers, chemists, teachers, draughtsmen, engineers, foremen, and superintendents. Of the number some have become partners in important business and manufacturing establishments, and up to the present time, of the whole number of graduates more than ninety per cent. are engaged in work for which their training at the Institute specially fitted them. The watchful interest here implied, as well as the care shown in recording the lives of the graduates, are noteworthy. Primarily the purpose of the Institute is the free education of youth resident in Worcester County, who desire to study on prescribed lines. Besides the free scholars others are admitted on an annual payment of 150 dollars or £30. In fact, so useful has the Worcester Free Institute become that it has commanded the spontaneous aid of some of the sister States. The legislature of the State of Massachusetts, in acknowledgment of the benefit to the Massachusetts manufacturing interests, made a special Worcester grant of 50,000 dollars or £10,000. Finally, as illustrating a single branch of instruction, that of engineering, we may mention that an alliance exists with the well-known Washburn machine shop, wherein the student may stand at vice or lathe or other tool, so that should he fail to secure a position as a consulting engineer he would at least have qualified himself by theory and practice for bread earning all his life in the capacity of a skilled mechanic.

Sibley College, New York State, is the mechanical and practical science training department of Cornell University. This University owes its name and existence to a munificent endowment by Mr. Ezra Cornell. As a supplement to the endowment, the University has a share in the benefit accorded by Act of Congress to science teaching, whereby public lands were granted to such States as should provide at least one college—"to teach," with other subjects, "such branches of learning as related to agriculture and the mechanic arts." The State of New York received as its share of the appropriation 990,000 acres of land, the income from which it assigned to Cornell University. Then Mr. Hiram Sibley has supplemented this by another endowment for a college of the mechanic arts, which College has assumed his name. Sibley College has a complete organisation, with workrooms, machinery, and machine shops. It is superintended by a director, assisted by professors, who give instruction in the working of wood and metals. The final outcome for the student is a qualification for the coveted degree of mechanical engineer; the course of study bringing into practical use the appliances of modern mechanical science in their latest forms. Part of the general course is instruction in the drawing-rooms. The drawing is in freehand for two terms, after which follows the mechanical course, with descriptive geometry. The workshop training is manual. This begins with a series of exercises in wood-working, which are intended to give the student familiarity with wood tools; and, as a whole, the exercises are expected "to enable the industrious, conscientious, and painstaking student" easily and exactly to perform the varied operations of the carpenter, the joiner, and the pattern-maker. He is actually put to work on structures, joints, patterns, core boxes, and other work in wood. Instruction in the same way follows in the machine-shop, the foundry, and the blacksmith's shop. After practice comes theory. This is communicated in the mechanical laboratory, where there is professional instruction of the highest order, with the use of scientific apparatus, which is provided without regard to cost. For the present, suffice it to state that Sibley College has been founded for the mechanic arts, that it is the wish of the trustees of Cornell University that, in addition to being a school of arts and trades, it should be a college of engineering, wherein may be developed as rapidly, extensively, and thoroughly as may be required, complete courses of instruction for placing the American student in the forefront as a worker in applied science.

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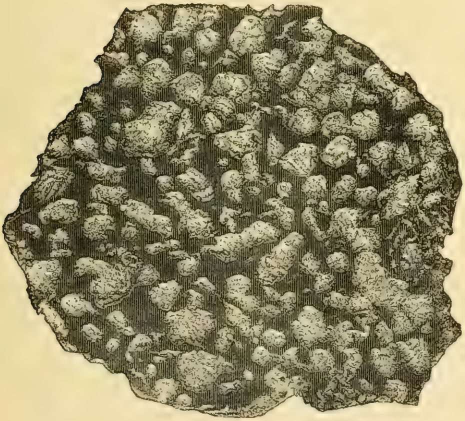
COMPETITION ON ALLOYS.—The Prussian Society for the Promotion of Industry has recently offered a prize of about £150 for the most exhaustive critical comparison of all kinds of existing bronze, tombac, and brass alloys, used or recommended for machinery; giving their chief properties with regard to resistance, ductility, friction at different temperatures, malleability, electric conductivity, behaviour with acids, hydrogen and carbon sulphides, chlorine, and other strongly corrosive substances met with in practice. The same society also offers a gold medal and £250 for the best work on light and heat radiation of burning gases. The time limit in the former case is the end of 1887; in the latter, the end of 1888.

## METEORITES.

WHEN Sir William Thomson gave his lecture on the sun's heat at the Royal Institution, he showed several fine specimens of meteorites, and through the kind-

<— — — 5 centimetres. — — —>

Fig. 1. METEORITE WHICH FELL AT POFSIL, NEAR GLASGOW.



<— — — — — —13½ centimetres.— — — — — —>

Fig. 2. SECTION OF METEORITE FOUND IN THE DESERT OF ATACAMA, IN SOUTH AMERICA.

ness of the secretary we are now able to give illustrations of them. The three meteorites shown in Figs. 1, 2, and 3 are the property of the Hunterian Museum of the University of Glasgow, the specimen represented by Fig. 1 being contained in the Hunterian collection, that by Fig. 2 in the Eck collection, and that by Fig. 3 in the Lanfine collection, the scale of dimensions being given for each. The stone shown in Fig. 1 fell on the earth at Pofsil, in the neighbourhood of Glasgow, on 5th April, 1804. Fig. 2 represents a section of the meteorite taken in the plane of the longest rectangular axis, the bright markings being large and well-formed crystals of olivine, embedded in a

<— — — — 9¼ centimetres. — — — —>

Fig. 3. SLAB OF CRYSTALLISED IRON FROM AEROLITE WHICH FELL AT LENARTO, HUNGARY.

<— — — — — — 15 centimetres. — — — — — —>

Fig. 4. CORRUGATED METEORITE WHICH FELL AT MIDDLESBURGH.

matrix of iron. This specimen was found in the Desert of Atacama, in South America, and is believed to have fallen there. In Fig. 3 is depicted the beautiful Widmanstätten marking characteristic of all meteoric iron. This splendidly crystallised piece of iron is a slab cut out of the celebrated aërolite which fell at Lenarto, in Hungary. Figs. 4 and 5 represent two views of the curiously shaped

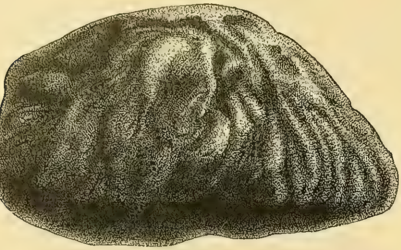


Fig. 5. Another view of the Middlesburgh Meteorite.

Middlesburgh meteorite, which has corrugations showing how its melted matter has been scoured off from the front part of its surface in its final rush through the earth's atmosphere when it was seen to fall on 14th March, 1881.

## FUNCTIONAL ACTIVITY.

DOES life in one or other of its functional manifestations immediately cease after decapitation, or is it prolonged for ever so short a time, reckoned by seconds? Is the brain capable of preserving some of its faculties for a short period after the head has been separated by violence? Hundreds of experiments have been made to find the solution of this problem by different *savants*, but not one was conclusive, nor even significant. The learned Professor Velpeau, however (as related by M. de Villiers in his new work, *Amour Supreme*), would seem to have obtained certain results *àpropos* of the execution of a Dr. la Pommerais for having poisoned Madame de Pauw. At the time the trial excited the greatest interest in the capital; it was one of the *causes célèbres* which are consigned to the pages of history. The eminent Professor went to see La Pommerais in prison a few days before his execution, and addressed him as follows: "I do not know if your appeal for a reprieve will be favourably received, but if rejected I have a proposition to make to you as a *confrère*, and in the interest of the profession to which we both belong. You are aware that one of the most interesting questions of modern physiology is to know if the slightest shade of sensation persists in the brain after decapitation. It depends on you to enlighten humanity on the subject. In the name of science listen to me. At the moment the knife falls I will be standing opposite you, and your head will be put into my hands by the executioner, and I will say distinctly at your ear, 'M. de la Pommerais, can you close three times successively the lid of the right eye, keeping the left widely open?' If you can by this sign prove that you have heard me, you will have cleared up an important scientific question, and you will leave behind you the *souvenir*, not of a criminal, but of a hero." La Pommerais asked a few days' reflection before answering this cold-blooded proposition. However, on the morning of the execution he informed Velpeau that he was ready. The head fell, and immediately the illustrious surgeon had it in his hands and pronounced the words agreed upon. To his great astonishment the right eyelid closed, while the left remained widely open. A visible effort was made to raise it again, but it remained closed, and the face became cold and motionless.—*The Medical Press.*

## THE PREPARATION OF ARROWROOT.

ACCORDING to the last report of the United States Commissioner of Agriculture, it appears that of late years a considerable impetus has been given to the cultivation and preparation of arrowroot in Bermuda, and large quantities are annually exported from the island. The cultivation is very similar to that of the common potato. The plants require at least a year to mature, and economical planters introduce intermediate rows of potato, the crop of which is ready for removal before it can injure the arrowroot. The mode of preparing the fecula from the roots greatly influences its value, and the superiority of the Bermuda arrowroot is attributed to the extreme care and cleanliness exercised in the different processes of manufacture. The roots, after being collected, are washed, and their outer skin completely removed. This operation has to be performed with great nicety, as the cuticle contains a resinous matter which imparts colour and a disagreeable flavour to the starch which no subsequent treatment can remove. After this process the roots are again carefully washed, and then crushed between powerful rollers, which reduce the whole mass to a pulp. This is thrown into large perforated cylinders, where it is beaten by revolving wooden paddles, while a stream of pure water carries off the fecula from the fibres and parenchyma of the pulp, and discharges it in the form of milk, through the perforated bottom of the cylinder, whence it is conveyed in pipes and passed through fine muslin strainers into large reservoirs. There it is allowed to settle, and the water is drawn off. After being repeatedly washed it is allowed to settle for some time, when the surface is skimmed with palette-knives of German silver in order to remove any slightly discoloured particles which may appear on the top, only the lower, purer, and denser portion being retained for sale. The drying process is conducted also with great care and cleanliness. The substance is spread in flat copper pans, and immediately covered with white gauze to exclude dust and insects. These pans are placed on rollers and run under glass-covered sheds when there is any danger from rain or dews. When thoroughly dry it is packed with German silver shovels into new barrels, these being first lined with paper gummed with arrowroot paste.

## WORK OF ART BY A BLACKSMITH.

IN mediæval times the blacksmith was the artist amongst craftsmen, as well as the one who, by making their tools and implements, made work by the others possible. The steel goblet represented on next page is presented as a work of art by a blacksmith of the present day. While we generally confine ourselves to the illustration of things having value in an economical sense, we have departed from usual custom for once, because it seems that such a piece of work has value in showing that craftsmen have not lost their skill, as is sometimes asserted. The following, which we extract from a letter written us by the Simonds Rolling Machine Company, of Fitchburg, Mass., tells what needs to be told about the steel goblet:—

"We send you to-day by express, a steel drinking goblet, hand-forged by our blacksmith, Mr. Fred. Searle, from a solid piece of $1\frac{1}{2}$-inch round steel, with no tools whatever but regular forging tools; that is to say, without any drills or boring tools."

To this may be added that the piece was put into the hands of the engraver, with instructions to represent it actual size, with all its imperfections, which has been very faithfully done. The hammer marks are slightly exaggerated, being scarcely perceptible in the original. The height is somewhat shortened, owing to the fact that it was necessary to represent it tipped forward a little, to show some of the interior. This somewhat injures the

Steel Goblet forged by hand without Drilling or Boring Tools.

fine effect of the work at the junction of the stem and body. It is a perfect goblet in every particular, the section through the body being very thin and even, and the interior perfectly formed and very smooth.—*American Machinist.*

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## UNIVERSITY COLLEGE, DUNDEE.

### Opening Address by Professor Carnelley.

PROFESSOR CARNELLEY said that in selecting a subject for his address, it seemed to him that it would be a fitting opportunity to give an account of a branch of chemistry which promises to be one where some of the greatest discoveries of the future will be made—discoveries which will be of the greatest interest, not only from a scientific point of view, but of the greatest importance as regards the welfare of the human race and of those portions of the animal and vegetable kingdoms which more especially minister to the needs and comforts of man. This branch of chemistry we may conveniently term bio-chemistry, or the chemistry of living things. It is that science which treats of chemistry in its relation to life and its attendant phenomena. It treats in brief of the action of dead matter on life, and of the mutual action of life on dead matter.

#### THE WONDERS OF THE LIVING ORGANISM.

The elements of which the earth's crust is composed—viz., oxygen, silicon, aluminium, iron, calcium, magnesium, potassium, and sodium—with the exception of aluminium, were absolutely necessary for life. The living organism was a great chemical laboratory—great not in a passive, but in an active sense; not as "being" but as "doing"; not great in the outward sense to the eye as occupying much space, and as having many elaborate appliances, but truly great to the inward sense—to the mind, as doing great and mighty things with small and apparently insignificant means, and yet doing all silently, surely, and perfectly. Think of the chemical changes brought about by the living organism, how silently and how surely its ends are reached—ends which are attained by the chemist in his laboratory only by the most crude and clumsy methods after many failures, and often very incompletely and imperfectly, and only after the most careful and elaborate thought. Think of the vegetable cell, so minute, apparently so simple in structure, and so poor in means, and yet a perfect laboratory in itself, carrying out many chemical changes within its small compass, and producing compounds which, at present, at least, are far beyond the ken of the most accomplished chemist.

#### WOHLER'S GREAT DISCOVERY.

Formerly it was thought that the compounds produced by living organisms were entirely distinct from those produced by the chemist in his laboratory, and that the former could only result from the action of the vital force. This distinction was, however, done away with when in 1828 Wohler produced urea artificially from inorganic materials. Since his day a very large number of substances, such as alazarin, indigo, etc., formerly only obtained from plants or animals, have been prepared artificially by the chemist, and it was known that the same laws regulate the chemistry of the products of both animate and inanimate worlds. So much so is this the case, that when the chemical constitution of any animal or vegetable product is known, the chemist is able, as it were, to make it to order. Though the chemist may make artifically most, if not all, the compounds resulting from the action of the vital force in the animal or vegetable cell, yet how the living organism produces the same result is still as complete a mystery as ever. Nor do our laboratory processes assist us in the least. For we cannot suppose that a plant goes through the processes of distillation and filtering treatment with such energetic agents as bromine, chlorine, sodium, etc., as the chemist would employ in the laboratory.

#### THE ACTION OF DRUGS.

The relation of chemical compounds—*i.e.*, of non-living matter—to living organisms is twofold:—(1) As regards the action of the chemical compound on the living organism; and (2) as regards the action of the living organism on the chemical compound. The action, however, is a mutual one. Just as in mechanics we have the well-known Newtonian law "that action and reaction are equal and opposite," so in the case of the administration of a drug, not only does the drug exert an influence on the living organism, but the latter in its turn exerts an influence on the drug. Thus the first and proper physiological action of morphia on the body is to produce sleep, and a distinctly soothing effect upon the stomach in allaying vomiting. In its passage through the body, however, the morphia not only acts upon the organism as described, but the organism likewise acts upon the morphia in such a way as to convert it into a substance called oxydimorphia. Now, the physiological action of the latter is almost the exact opposite of that of morphia itself, so that instead of having a soothing effect it produces excitement, with nausea or vomiting. Considerable judgment is therefore required in the administration of morphia.

#### MINUTE FORMS OF LIFE.

The action of living organisms on chemical compounds was, on account of the essential part which minute forms of life play in affecting chemical changes, which are necessary for the well-being of animated nature, of great importance. In many kinds of fermentation, such as brewing, baking, extraction of dyes from the woods; in putrefaction, which is so necessary for getting rid of deleterious organic matter; in the nitrification of the soil, whereby plants obtain the nitrogen required for their growth, and more especially for their fructification; in a large number, and probably in all, infectious diseases, the action exerted by living organisms on chemical compounds is the all-important factor. It is chiefly to the brilliant researches of Pasteur that we are indebted for the proof that the processes of fermentation and putrefaction are due to the action of minute living organisms, while Koch and others have indicated the import and part which these lower forms of life play in the case of many diseases both in man and animals.

### MICRO-ORGANISMS NOT THE CAUSE OF DISEASE.

The latest researches, however, have shown that the direct cause of an infectious disease is not the micro-organism himself, but that it is due to the poisonous effects of the compounds resulting from the chemical action of the micro-organisms on the tissues or fluids of the body. An infectious disease is due, therefore, to the products formed by the micro-organism rather than to the organism itself, for it has quite recently been shown that the disease can be communicated by such poisons in the entire absence of living organisms. The compounds produced by living ferments, and indeed by all micro-organisms, usually act as poisons to these ferments, so that if the products accumulate beyond a certain extent they kill the ferments. This is exactly analogous to the higher animals and to man. One of the most important products of animal life is the carbonic acid produced by respiration, and we know that if this carbonic acid be allowed to accumulate beyond a certain amount the animal soon dies. In this way the yeast plant, when living in a solution of sugar, is killed by the alcohol it produces as soon as the proportion of the latter amounts to 20 per cent.

### THE ART OF BREWING.

Though the art of brewing has been known for at least 2,000 years, and though the manufacture of wine was carried on so early as the time of Noah, yet nothing was really known as to the *modus operandi* of the production of beer and wine. The brewer and wine-grower learnt from long experience the conditions but not the reasons of success. No man, in fact, knew the secret of their formation. It is to the splendid genius of Pasteur that we chiefly owe our present knowledge of the real agents in fermentation. He has shown that grape juice ferments in virtue of the action of a minute micro-organism which at the time of vintage is found adhering as a parasite to the outside of the grapes and the adjacent twigs, and that yeast induces the fermentation in brewing in virtue of its being a living organism; and that in each case the resulting alcohol is a product of the growth of these micro-organisms, just as carbonic acid is the product of the life of man and the higher animals, or as india-rubber is a product of a special kind of plant. The brewer is a kind of farmer. But whereas the farmer sows his corn to get more corn, the brewer sows his yeast to produce certain chemical changes in the wort, resulting in the formation of alcohol and the production of beer. In this connection it is interesting to think that the yeast used by the brewer to-day is the lineal descendant of the yeast used by brewers more than two thousand years ago.

### PUTREFACTION.

Until quite recently the putrefaction of animal and vegetable matters was thought to be entirely a process of oxidation, and, in this respect, to be strictly analogous to the rusting of iron and in the atmospheric corrosion of other metals. But it has been conclusively shown that pure air, even in the presence of moisture, is quite incapable of producing putrefaction, and that the presence of living organisms is absolutely necessary for inducing putrefactive changes. It seems that the chemical action of these micro-organisms is somewhat similar to what takes place during ordinary digestion. The micro-organisms abstract the elements they require, and the remainder react on one another to form new combinations. In the process of decomposition certain products are formed, called ptomaines, which are closely allied to strychnine, morphine, etc., and are frightful poisons. The poisonous properties of various kinds of food which have undergone putrefaction are due to the presence of these ptomaines, resulting from the action of the putrefactive micro-organisms. This has been the case with several well-known instances of sausage-poisoning, poisoning by bad fish, and even with mouldy bread. The formation of these ptomaines during disease or after death has a most important bearing upon the treatment of cases of suspected poisoning in criminal trials, inasmuch as whether poisonous or not their reactions differ very little from those of the deadly alkaloids; and in the interests of justice it is to be hoped that our knowledge of this branch of organic chemistry may soon be rendered as complete as possible.

### THE LESSON OF BIO-CHEMISTRY.

Bio-chemistry, and especially that part of it dealing with micro-organisms, teaches us at least one lesson, and a lesson, too, which is in unison with that taught by nature generally, viz., that the great things and phenomena of the world and of the universe are accomplished by apparently insignificant, and, at first sight, insufficient means. Were the larger animals, such as the great carnivora, annihilated, the world would not be very different from what it is. Annihilate, however, the almost infinitesimally minute micro-organisms of fermentation and putrefaction, and the result would be a total revolution as regards the life of the world. What is it that strikes the greatest terror to the heart of man? It is not the tramp of armed men led by a Hannibal, a Cæsar, or a Napoleon, nor the howling of beasts of prey. It is the silent march of a dread disease, of the inconceivably minute organisms of cholera, of small-pox, of consumption, or other like scourges of the human race. Pure and moteless air gives perfect immunity from putrefaction and disease, but consider the dread effects which have followed the course of air charged with the germs of an infectious disease; of what sorrow, what sickness and death has it been the cause in ages past. Even the terrors of the battlefield itself often sink into insignificance by the side of the ravages occasioned by the sickness and disease resulting from the putrefactive micro-organisms of the air, let loose on the living and the slain. It is no exaggeration to say that micro-organisms wafted in the air have been the cause of greater calamities than all the wars, earthquakes, famines, and the like put together.

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## NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

ABRIDGMENT OF THE PRESIDENTIAL ADDRESS OF SIR LOWTHIAN BELL, F.R.S.—*continued.*

The numbers just quoted indicate with sufficient clearness how largely modern navigation is indebted to coal for the immense strides it has made in recent years, and although its dependence on the use of iron may not be so obvious, we are all aware that wood is now but very sparingly employed in naval architecture. Indeed its use may be said to be confined to forming the deck and lining the cabins of our ships. Let us now briefly consider what has been done in order to connect continents with each other by sea, in a manner more consistent with what the locomotive had achieved in uniting districts and nations by land than could have been accomplished by wooden ships depending on the wind for motion.

In our Exhibition there may be seen a very beautiful model showing the design of a steam engine estimated to work to nearly 25,000 indicated horse power, about to be constructed on the Tyne for an Italian ship of war. We also know that ocean-going steamers of very large dimensions have been built capable of running 25 miles in the hour—a speed equal to that of our best trains 50 years ago. The strain imparted to the hull of a vessel under such trying circumstances as those just mentioned, makes it more than doubtful whether it would have been possible to obtain the necessary strength with wood, forming as it were a hollow foundation of a comparatively weak material, to connect these tremendous forces with their work. If this view be correct in principle, the adaptation of iron for the frames and planking of our ships is a very important factor in the enormous development of steam navigation. It may be questioned whether, at the commencement of the reign of Queen Victoria, there was a single sea-going vessel of iron afloat. Thirteen years after Her Majesty ascended the throne there was built in the United Kingdom 132,800 tons of shipping, of which 12,800 tons only were of iron. In 1883 we launched in this Kingdom 1,116,555 tons, that is, more that eight times the amount built in 1850; and of this 16,353 tons only were of wood, and the remainder of iron. I am not aware of the exact number of iron vessels now in existence, but I have estimated that in the seven years ending 1884, close on 4,000,000 tons of iron and steel had been consumed in hulls and engines by our shipbuilders. Of this weight about 763,000 tons were used in 1882, followed by about 860,000 tons in the year 1884.

It has to be borne in mind that a great increase in strength was not the only advantage attending the substitution of iron, and afterwards of steel, for wood in the construction of our ships. The saving of weight, particularly when using the last mentioned material, is such that it increases the capacity of the vessel sufficiently to contain in the space gained more than coal enough to take her across the Atlantic. It will be interesting to review, however shortly, the other causes in addition to this which have so entirely falsified the prediction of Dr. Lardner and others. In the early years of the engines built by James Watt it was deemed, no doubt principally on account of imperfect workmanship, inconsistent with safety to use a piston speed exceeding 220 feet per minute. In the case of marine engines, as well as others, improved machine tools enabled our builders to obtain a much higher velocity, but this was limited by the weight and dimensions of the paddle wheels in large ocean-going steamships. This impediment to progress was removed by the invention of the screw which permits three times the rate of piston speed laid down by Watt. To follow up this improvement a great extension of boiler power was needed beyond that required by this great engineer. The use of cast iron boilers, one of which was working in my own time in Newcastle, and afterwards those built up of small plates, sufficed for the low pressure steam employed in his condensing engines. By more suitable iron used in boilers of improved construction, steam was employed at such a pressure that a vessel having a carrying capacity of 3,750 tons could land in New York a cargo, taken in at Liverpool, weighing 3,000 tons. This was enough to enable her to cross the Atlantic in 14 days with a consumption of 750 tons of coal.

The capacity of steam as a propelling power depends of course on volume and pressure, and hence on the temperature of that passing through the cylinders. We all know how the dangers attending the use of steam at a high pressure have been met by the introduction of the compound system, in which, by the use of three cylinders, a great addition to the expansive force of the steam is now very largely employed. To such an extent has this been carried, that 350 tons of coal are now doing the work which formerly required 750 tons, enabling such a vessel as I have selected for illustration to carry 3,400 tons across the Atlantic, instead of 3,000 as formerly. The application of very highly heated steam has of course its limits, connected with the action of heat on the oil, etc., used for lubrication, as well as that on metallic surfaces themselves, when exposed to friction. Into these questions of detail it is not however necessary here to enter.

If we go back 120 years, when steam power was beginning to be applied to the drainage of our coal pits, the duty performed was very low, namely, about 64,000 lbs. of water raised one foot per lb. of coal burnt. The engines then used owed their motion to the pressure of the atmosphere, steam being merely employed to obtain a vacuum by its condensation, got by injecting cold water into the cylinder. James Watt effected the same end by a separate condenser, and then proceeded, in addition, to work his steam expansively, by which he raised the duty to 316,000 lbs. Gradually, by means of more highly-pressed steam and better-constructed engines, the duty was increased to above 950,000 lbs. The researches of Black, the chemist, on latent heat first directed the attention of Watt to separate condensation, which, with the observation of practical engineers of great skill, constituted the only guides for improving the steam-engine, until Joule's determination of the mechanical equivalent of heat in 1843. By this distinguished physicist it was ascertained that in burning a single pound of coal there was energy developed equal to raise 11,422,000 lbs. one foot high, but that the actual useful effect obtained from a steam-engine and good boilers did not when he wrote exceed 1,000,000 lbs. raised one foot in height, showing a loss of 91·25 per cent. of the power of the coal. This information to the engineer is invaluable, because it enables him to realise the exact amount of his loss, and also forms the key in looking for its cause. It was to avoid this loss that Ericsen and others suggested and built engines to be driven with heated air. The amount of pressure which can be commanded, even at a temperature as high as 480° F. (177 C.), is, however, so small that the machinery for utilising it must have unmanageable dimensions.

Although the existence of coal in our immediate neighbourhood was known to the Romans, it may be estimated that one-half of the entire output got from the field up to this time has been worked during the last twenty-five years, so rapid has the recent increase of the demand on its resources been. Having regard to its ascertained extent, unless its boundaries are enlarged by some unexpected discoveries, which is more than problematical, we or our successors must begin before long to prepare for a diminished produce and increased cost. It is true Dr. Lardner told us, forty years ago, to be under no apprehension in respect to our position when our national beds of coal became exhausted; for he assured us that the operations of nature afford abundant hope of a substitute being found, electricity and hydrogen gas got from water, however, being the only ones he specified. Mr. Mulhall repeats this opinion as regards electricity in 1880,* alleging that this agent is *already* supplying the place of coal. He seems, however, apparently to disregard the fact that nearly in every case the electricity was being obtained by burning coal under the boiler of a steam-engine. Everyone who has bestowed a thought on the operations of nature, referred to by Dr. Lardner, knows the sun to be the source to which they owe their existence. The potential rays of this luminary continue, as they did in pre-historic ages, to dissociate the elements of the carbonic acid of our atmosphere, leaving their immeasurable energy transferred to the numberless forms of vegetation which cover the face of the earth. The same power creates currents of air and raises the water of the ocean to the summits of mountains. Thus we have the heat which split up carbonic acid into its elementary constituents; which rarified the air and evaporated the water, capable of being returned to us in the form of motion; or, if we choose, such motion may be reconverted into heat by means of suitable appliances.

When, however, we set to work to consider the adaptation of the operations of nature as they are taking place under our eyes, we shall find that enormous periods of time or vast areas of space are involved in their application. It has been estimated that thousands of years were needed to produce the beds of coal which were formed beneath the surface of this and the adjoining county. The charcoal capable of being grown in a year on an acre of land would only suffice to propel one express train over a distance of twenty-five miles; and for making the pig-iron annually produced in Great Britain a forest of 42,000 square miles would be required. As regards the movements in our air, Jevons calculated that it would take 1,000 wind-mills to drive a modern rail-mill. This would mean lines of these engines extending over something like twenty miles, and all to be connected with the fly-wheel shaft of the rolling machinery. The collection of the rain which falls over a large area of country into rivers affords, it is true, a ready means of concentrating its power at one point. The advantage thus placed at our disposal is obtained at a sacrifice of that portion of the force represented by the descent of the water from the more elevated and often less extensive parts of the field which is drained. Let us suppose that in order to secure the necessary volume of water the barrier of interception is placed fifty feet above the sea level at high tide. If we assume the annual rainfall over the entire acre to be 3,000 tons, and none being lost by evaporation or otherwise, the whole to fall over the height just referred to, we should have a yearly mechanical force of 336,000,000 foot pounds. This, according to Joule's investigations, after allowing 30 per cent. loss of power for friction in a water wheel, would only represent 20·6 lbs. of coal; but we have seen that in one way or another 90 per cent. of the power of coal may escape in its application; hence, the 3,000 tons of water collected on an acre of land in one year would, in falling from an altitude of 50 feet, afford in available power, after deducting this loss of 90 per cent., an equivalent of that obtainable from 206 lbs. of coal burnt under the conditions already described. It would be easy to calculate the amount of energy capable of being derived from impounding tidal water. The result, however, would only resemble, in its general outlines, that afforded by the examples already given. There are, it is true, certain cases in which the heat required has to be generated under conditions where its cost practically forms no element in the calculation. If, for example, it is desired to despatch a mass of iron weighing 1,800 lbs. on a journey of half-a-dozen miles, the terminus of which must be reached in a few seconds, we must employ suitable means for the instantaneous development of the necessary heat. For this we need an Elswick gun for our furnace, costing it may be £20,000, and 960 lbs. of gunpowder for our fuel, costing £60,

* "Progress of the World," p. 68.

Notwithstanding the expensive plant and material used in burning gunpowder, it is interesting to know that the 960 lbs. of this fuel evolves no more heat than can be afforded by about 160 kilogrammes or about $3\frac{1}{4}$ cwts. of coal.

The improved means by which motion can be converted into electric heat may appear to justify the opinion of Dr. Lardner, and encourage the hope, often repeated since his time, that this agent may take the place of our coal after the exhaustion of our beds of this mineral. If the object to be gained were the dissociation of carbonic acid and the fusion of the separated carbon into a diamond, instead of moving a railway train at the rate of 50 miles an hour, at the cost of 1d. per train mile for fuel, there might be room for argument. Clearly neither of the instances just referred to affect the question before us, which in point of fact is as follows:—We now possess coal occurring under such circumstances that an acre may contain 20,000 tons or more, out of which a collier can hew for his day's work as much as will make two tons of pig iron, or move a railway train weighing 300 tons over a distance of 300 miles at the rate of 40 miles an hour. The problem therefore before us is to estimate the position of a nation, no longer possessing a material so easily obtained and endowed with so much potential energy as coal, compared with other nations having unlimited resources of this mineral at their command. There are those who attach some weight to chemical action as being able to supply us with electric heat, and with it, electric power, when our coal is exhausted. All this, however, as far as our present knowledge enables us to see, means a previous expenditure of heat. A common source of electricity generated by chemical action is the oxidation, or burning as it may be termed, of some of the metals, of which zinc is the one in most common use. This as well as others, if ever they existed in nature in the metallic state, have, since then, become oxidised. To fit them therefore for undergoing this process a second time, heat must be employed, and this is generally accompanied with great and unavoidable loss, which, along with other expenses connected with their production, forbids our looking for any assistance in their direction. Quite as extravagant as the use of zinc was Lardner's idea of employing the hydrogen of water as a source of heat. Water, being simply burnt hydrogen, as much heat would be absorbed in separating it from its oxygen of combination as it is capable of yielding by burning it a second time. We might therefore as reasonably expect a wheel to raise to the level of the buckets receiving the water all that which had served to move it, as to obtain heat from the hydrogen of water, or worse still from chalk, as was insisted on by the Rev. W. Moule. What has been said in reference to the use of electricity as a source of motion, or even of heat, to which may be added that of light, must not be considered as of universal application. Thus there are situations in Alpine countries where continuous supplies of water descending rapidly from great heights could, by means of turbines, furnish enormous power. This power could, by the aid of electricity, be transmitted to a distance, as is now done by compressed air in our coal mines, or still more frequently by hydraulic machinery, in the manner first proposed by Lord Armstrong. For the utilization of the power on the locality where it is easily obtained from the fall of water, we need not wait for further discoveries in electrical science to assist us in turning it to useful purposes. It must always be more economical to employ the power *direct* so as to avoid the loss, as far as possible, arising from the friction which is inseparable from the delivery of mechanical energy for actual work.

There have been found in nature, as every one knows, vast stores of liquid and gaseous hydrocarbons, which are being extensively employed as a source of heat. With these we need not concern ourselves, because, so far as exhaustion goes, oil springs and gas wells will be subject to the same laws as those which obtain with coal. With the facts and figures just given before us, instead of spending time and money in searching for substitutes for the fuel now in common use, we would act more prudently in looking for means to reduce a waste, which, when mechanical power is the object to which it is applied, amounts, as it often does, to 90 per cent. of the capacity of the coal.

Not inferior as a national calamity to exhaustion of our coal would be the want of iron. Without this metal, coal, at the depths it is often found, would be beyond our reach; or, if reached, we should frequently lack, commercially speaking, the means of utilising the object of our search. That the loss of this mineral would extinguish the manufacture of iron is proved by the experience of the last century; for in 1740, owing to the woodlands near the works failing to afford the necessary supplies of charcoal, the make of iron had declined until it did not reach, in that year, the quantity produced in one of our modern furnaces. From this threatened annihilation Abraham Darby's success in the application of coke for smelting iron ore relieved us. The production of cheap iron may, for some centuries, be considered as dependent on our being able to command cheap coal; because the known deposits of ore are too extensive to render it necessary to concern ourselves about their exhaustion. The extent to which iron has assisted in the enormous development of our national industry is evidenced by the large increase in its use. Fifty years ago the annual consumption per head of our population was under 80 lbs. In the year 1884 it amounted to nearly 290 lbs., while the average of the whole world was only a little above 30 lbs., and among some hundreds of millions of people it is under half a pound. In the year 1837 the make of pig iron in Great Britain was a little above 1,000,000 tons. Since that date (namely, in 1882), it was close on $8\frac{1}{2}$ millions. This great and rapid progress in production was not confined to our own country, for between 1879 and 1883 the world's output of pig iron rose from 14,000,000 to 21,000,000 tons. Very great changes in the processes connected with the manufacture of this metal in its various forms have no doubt promoted its extended consumption in recent years. At the same time it must be allowed that our knowledge of the metallurgy of iron fifty years ago was sufficiently advanced to have enabled us to supply the metal then, of a sufficiently good quality, and at a sufficiently low price, for any purposes for which it was wanted. In addition to the extensive but somewhat expensively worked deposits of ironstone of South Staffordshire and South Wales, Scotland had been proved to contain a large quantity of Black Band ironstone, while Cumberland and Lancashire gave good promise of being able greatly to add to their yearly output of rich hematite ore. In the works, the puddling process, although a laborious operation, had been brought to a state of great perfection, and the value of the hot blast in smelting had been sufficiently demonstrated.

The twenty-five years after 1837 added however greatly to our information connected with the manufacture of iron. The existence of the great Cleveland bed of ironstone, and subsequently that of Lincolnshire and Northamptonshire, had been discovered, and the processes known as the Bessemer and Open-hearth for making steel had been invented. During a few years following 1862 the Middlesborough ironmasters, by an enlargement of their furnaces, and by raising the temperature of the blast from 315° as recommended by Neilson to 537° C. (600 to 1,000° F.), added to an extended use of the escaping gases, had effected a saving of one-third of the coal required to produce a ton of pig iron. Immense improvements in rolling-mill machinery and ameliorations in the Bessemer process have so reduced the cost of making steel rails, that this article, made from ore brought from Bilbao in Spain, has been sold for what, sixty years ago, would have been considered but a reasonable price for pig iron obtained from native ore. Without troubling you with unnecessary details in the manufacture of iron I may say that, within my own recollection, to make a ton of iron rails, beginning with the ore, about $7\frac{1}{2}$ tons of coal was consumed, and now a ton of steel rails does not require above $3\frac{1}{2}$ tons of fuel for its production. This great economy in the manufacture of steel, combined with its superior strength and malleability, has led to its extensive use for purposes in which wrought iron was formerly employed. At present, nearly half the malleable form of the metal produced in this country is obtained from the Bessemer converter or from the Open-hearth furnace, and the change is one which is gradually extending. The increase of strength in steel as compared with iron, just referred to, has very much assisted in combining great power with lightness in the construction of the modern steam engine. A striking example of this is to be seen in the Exhibition, where the actual machinery, capable of developing an indicated power of 1,750 horses, weighs something under 26 tons. To this proof of power in resisting enormous strain may be added that afforded by the use of steel in the heavy guns from the Elswick works. On the other hand the malleability of this form of iron, and its simplicity and consequent economy of manufacture, are such that the large boiler plates, also to be seen in the adjoining building, can be sold at about one-third of the price charged for iron plates of similar dimensions.

I would here, in connection with the steel trade, refer very shortly to a question of local interest. As those acquainted with the properties of iron know, phosphorus unfits the pig containing it for either of the new modes of manufacture. So hurtful is this element, that its presence to the extent of one part in one thousand of the metal would cause its rejection by the steel manufacturer. Now, our local iron from the Cleveland Hills usually contains seventeen times more phosphorus than the quantity just named; thus we have been compelled to supplement the purer hematite of the west coast by large importations of ore from abroad, chiefly from Spain, in order to supply the constantly increasing demands for Bessemer and Open-hearth steel. It was proved by M. Grüner, of Paris, that it was the acid properties of the silica in the slag which prevented a second acid, like the phosphoric, being carried off in this siliceous slag, generated during the operation. By neutralising the acid properties of the silica by means of lime, the obstacle to the formation of a compound containing phosphoric acid was removed. This constitutes what is well known as the Basic process; but this adaptation of pig-iron containing phosphorus for steel-making may, however, have an importance beyond that of a purely metallurgical character. This element has long been recognised as an indispensable ingredient for animal life; its presence, therefore, in our food is a necessity from which there is no escape. The proper vehicle through which this phosphorus can be conveyed to the animal kingdom is through the vegetable. Continuous crops removed from the soil in time exhausts its store of phosphorus, and this needs renewal, which is done by the familiar use of manures. It is alleged that the phosphorus contained in the "Basic slag" is capable of being assimilated by plants, so that we have a substance which depreciates the market value of the phosphoric pig-iron of our country to the extent of ten shillings per ton converted into a source of positive wealth. It has been my endeavour in what I have said to bring under your notice how our abundance of coal and our great resources of ore have enabled us to produce cheap iron. Incidentally I referred to the date of the substitution of pit coal for charcoal for smelting the ore, to the invention of the puddling process, to the introduction of the hot blast, to the great enlargement of our blast furnaces, and to the discovery of new processes for making steel. Let me now add that not only have these changes greatly reduced the cost of the metal, raised its value, and enabled its production to be continued in Great Britain after increased population would have rendered this impossible, but the improvements themselves, with the exception of the Open-hearth process, were originated on British soil by British minds.

In France and Germany the coal has to be conveyed to the iron ore, or the ore to the coal, over greater lengths of railway than intervene between the two minerals in England or Scotland. In the United States this prevails to a striking degree, for there we often hear of journeys of 500 and even 1,000 miles having to be performed in order to bring these raw materials together, and almost everywhere the distances of the manufacturing centres from the sea are usually very much greater than with us. In the United Kingdom those distances are sometimes only thirty miles, and rarely exceed 100 miles. In like manner the improvements connected with the production of iron have, as we have seen, been accompanied by great economy in the consumption of coal—a change which, for the reasons just given, has proved of greater advantage to foreign manufacturers than to our own. On similar grounds there is no doubt that the Basic process for making steel has proved much more beneficial to France and Germany than it has been to us in the country where it was invented. The long-continued depression in our trade generally, accompanied by a retrograde movement in the volume of some branches of it, has given rise to much apprehension among political economists, as well as among others more directly concerned in our commerce. This feeling has naturally been aggravated by the knowledge that, while our products were declining in amount, those of certain foreign countries were advancing. Among the conclusions arrived at is an inferiority in point of education to that of our competitors of other nationalities. This I believe to mean a deficient scientific education on the part of those connected with the direction of our industrial operations. Well, there is no denying that Germany in particular recognised sooner than we did the importance of education among all classes as the only safe ground upon which national progress could be founded. We have only to consult the dates of the literature on mining and metallurgy to learn how much earlier than ourselves, not only the Germans, but the Swedes, French, and Belgians occupied themselves with a scientific consideration of the questions involved in the cultivation of these arts. We have, it is true, made considerable progress in this direction in recent years; but I am not prepared to say that the same amount of importance is attached to, and the same general proficiency in scientific knowledge prevails with us as are to be found elsewhere. From this state of comparative indifference and from this condition of comparative ignorance, if they exist, we must emancipate ourselves with the least possible delay. We have harvested all the fruit we can calculate on gathering in the absence of that guide which science can alone supply, and for the maintenance of our industrial position we must turn to scientific instruction or be content to remain behind in the race. It cannot, however, I would submit, be maintained with any justice that British manufacturers—at all events, those whose work is of a kind with which we are familiar in the north of England—are now indifferent to scientific education. How can we, were it otherwise, account for the existence and flourishing career of such societies as the Institution of Civil and that of Mechanical Engineers; of the Institutes of Iron and Steel; of Chemical Industry; and, not least among the number, the Institute of Mining and Mechanical Engineers of the North of England, the oldest among several in other parts of the kingdom devoted to the science of mining, etc.?

Besides the fears which have been expressed with regard to the ability of those who direct our workmen, some alarm appears to be felt respecting a supposed decline in the proficiency of the artisans themselves. I shall leave the defence of those engaged in branches of industry with which I am but imperfectly acquainted to others; but in regard to those connected with the use of iron and steel I would invite a careful inspection of the workmanship displayed in the objects to be found in our local exhibition, as an unanswerable proof of the groundlessness of these apprehensions we have to listen to from time to time. I am not going to deny that I have myself heard, from judges of undoubted capacity, of the high class of foreign workmanship as compared with some of British origin; but it has always been a question in my mind whether inferior work, purchased here at a low price under the influence of excessive competition, has not been contrasted with that of a better paid description produced in foreign workshops. The official statistical abstract of our exports, however, furnish the best answer to this imaginary decadence of skill on the part of our workmen. In 1870 the value of the machinery sent to foreign countries from our shores amounted to £5,273,273. In 1880 it had risen to £9,263,526, and in 1883 to £13,433,081; the average of the five years ending 1885 being £11,696,574; and all sold in markets in which the competition of the whole world had to be met. The arguments made use of in reference to the undoubted manner in which our position as a manufacturing nation is being contested by other countries, seems to proceed too much on the assumption that we possess an intuitive genius for industrial work not found in other nations; and, relying on this, we are losing our rank by a neglect of those educational measures which may end in our having to resign to, or at least to share with others, the honours we have for some years enjoyed.

As a matter of fact, the Dutch, Flemish, Germans, and French, a couple of hundred years ago, were to a great extent our teachers in the manufacturing arts. Even in iron, which owes so much to British enterprise for its subsequent development, the Germans, up to the middle of the last century, taught us nearly all we knew, including the use of the blast furnace itself. The possession and early knowledge of the existence of large deposits of fossil coal enabled us to revive our moribund manufacture of this metal upon which all other industries depend. While the four nations named above were distracted by the presence of large bodies of armed men, engaged in almost incessant conflict, our manufactories, unhampered by actual war in our midst, made rapid progress. This progress, after the establishment of peace in 1815, with almost the entire world for our customers, was continued for many years. In the meantime, fresh coal discoveries were being made on the Continent of Europe as well as in America, and eventually any difficulties in rendering these new resources available, by reason of situation, were overcome, as we have seen, by the introduction of railways and other improvements. The manufacturing energy was revived in the Teutonic and Latin races in Europe, and that of the

Anglo-Saxons was transplanted to and flourished in America. As a result our example has been followed, and our experience rendered useful, and in some cases improved, by those whose competition we have now to face. Such was the activity throughout the world that, as we have already seen, the annual increase in the total make of pig-iron was 50 per cent. between the years 1879 and 1883, namely from 14 it rose to 21,000,000 tons. In this struggle for supremacy we lost, in relative advance, the position which we had occupied probably for the last 100 years. Between 1870 and 1883 the increase of our production was only 31 per cent., while that of the other nations amounted to 138 per cent. At the same time we still remain the largest makers of iron in the world, the chief producers standing for the year 1886 in the following order:—Great Britain, 6,870,665 tons; United States, 5,683,329 tons; Germany, 3,489,400 tons; France, 1,507,850 tons; Belgium, 697,100 tons. The make of this country, it must, however, be remarked, fell from 8,493,000 tons in 1882 to the figure just given.

The rapid increase in the case of Germany and Belgium has compelled these two nations to become exporters to the extent of fully one-third of their united make. It may appear extraordinary that, being protected from importations from Great Britain by the cost of the transport, the further protection of import-duties is levied, while, at the same time, these countries meet us in neutral, and indeed in our home markets, with something like 2,000,000 tons of iron annually, upon which they have generally more to pay for carriage than we have, and upon which they lose the advantage afforded by the import duty. There are indications that a position of maximum consumption of iron has been reached in our own country, inasmuch as the quantity, including that used for machinery exported, has remained pretty stationary during the last dozen years, fluctuating between 3 and 3½ million tons. On the other hand, our exports of iron have decreased to the extent of about 1,000,000 tons annually. These figures, taken alone, may well lead the British public to fear that their own iron makers may be failing either in intelligence or in energy, or in both. This is not true; no nation, taken as a whole, possesses greater natural advantages for the successful pursuit of this branch of industry, and of its advantages Great Britain makes as good a use as any other people do of theirs. It has to be admitted that during the last few years not only has our production fallen off, but what we have made has left little, or in many cases no profit to the manufacturer; but in this respect we do not appear to be worse off than our neighbours. According to a published list, out of 18 works engaged in manufacturing and mining operations in Germany, only two made a profit exceeding 10 per cent.; eleven varied from ⅓ per cent. to 4½ per cent.; and seven realised no profit or made an actual loss.

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THE STEAMSHIPS OF THE WORLD.—Recently published statistics show that the estimated number of steamers existing in the world in 1886 was 9,969, having an aggregate burden of 10,531,843 tons. In 1885 the number was 9,642, with an aggregate burden of 10,291,241 tons. The steam shipping of the world in 1886 was thus distributed:—Iron steamers, 8,198, of an aggregate burden of 8,911,406 tons; steel steamers, 770, of an aggregate burden of 32,820; and wooden steamers, 822, of an aggregate burden of 380,655 tons. Of the steamers afloat in 1885, 5,792 were owned by the United Kingdom and its colonies, their aggregate burden being 6,595,871 tons. The other countries of the world owned steamers in the following order:—Germany, 579; France, 509; Spain, 401; the United States, 400; Norway, 287; Russia, 212; Denmark, 200; Italy, 173; Holland, 152; Brazil, 141; Japan, 105; Greece and Turkey, 82 each; Belgium, 68; Chili and the Argentine Republic, 43 each; China and Portugal, 27 each; Hawaii, 21; Mexico, 15; and miscellaneous, 50.

HEATING BY STEAM.—The *Master Steam Fitter* gives the following rule for finding the superficial feet of steam-pipe required to heat any building with steam: One superficial foot of steam-pipe to six superficial feet of glass in the windows, or one superficial foot of steam-pipe for every hundred square feet of wall, roof, or ceiling, or one square foot of steam-pipe to eighty cubic feet of space. One cubic foot of boiler is required for every hundred cubic feet of space to be warmed. One horse-power boiler is sufficient for forty thousand cubic feet of space. Five cubic feet of steam, at seventy-five pounds pressure to the square inch, weigh one pound avoirdupois.

## REVIEWS.

*The Architect's Register.* Vol. II. Illustrated. Issued half-yearly for the use of architects, engineers, builders, contractors, and others. London: W. Pope, 16, Holborn, E.C. 1887.

The primary object of the compilation is the publication of such papers of merit as have been read before architectural societies, which otherwise would not be published. House Sanitation, by Dr. W. H. Corfield, professor of hygiene and public health, at University College, London, is the first paper. According to this gentleman, the examination of a house should begin with the roof and the ventilating pipes, which last should be of adequate size, and carried above all parts of the building, with the exception of the chimneys. Next, he discourses on the cowls, which should be adopted for crowning the ventilating pipes, and then passes to the adequacy of the discharge of rain water from a roof. In the inside of a house the first care should be the condition of the cistern, and keeping this in view, he says that lead in cisterns and pipes is not nearly so mischievous as it is commonly made out to be. The effect, he says, of ordinary town water on lead is inappreciable. The sink should be against an external wall, with a window over it, capable of affording ample ventilation. The waste pipe from a kitchen sink should end in the open air, over a trapped gully, and from an upstairs sink the waste pipe should be carried through the external wall and discharged into an open pipe. Much is added about water closets, and the fact is mentioned that a considerable degree of perfection in these apparatus was introduced by Alexander Cummings so long ago as 1776. Drains, syphon-traps, and flush tanks close the subject. The second paper, by Mr. Walter Crane, is in some measure a comparison of the art of the present day with that of the past, especially with the mediæval and classical past. It has been contended that the Exhibition of 1851, as those of later years, has had the effect of vulgarising and commercialising art, but Mr. Crane's opinion is that the exhibitions have been a summing up of change, which he thinks must be obviously refining. In support of this view he instances the necessary influence upon the national taste of the Christmas scatterings of oil paintings, after our first masters, fresh from the printing press. The next paper, on Welsh Churches, by Mr. A. Baker, may be summarised into, respect tor their historic value, respect for their art value, and into the professional lessons in restoring them. Mr. Baker finds that the cost of restoring village churches of ordinary type averages from 15s. to £1 per superficial foot of the whole area of the church, the fittings if required being in oak, and the roof in oak and re-slated. We shall hereafter turn to the remaining papers of the series, space alone precluding present mention of them.

*Metal-plate Work: its Patterns and their Geometry.* By C. T. Millis, M. Inst. M.E. London: E. and F. Spon, 125, Strand, and 35, Murray-street, New York, 1887.

This is one of the Finsbury Technical Manuals, and Mr. Millis is the lecturer on metal-plate work and practical geometry at the City and Guilds of London Technical College, Finsbury. The prevailing reflection while reading this useful volume is, that the days of rule of thumb are ending, and that the artisan classes, for whom the book has chiefly been written, must at length combine principles with manual dexterity. They must master the problems of angles, lines, circles, polygons, ovals, ellipses, and oblongs, and if all this is not done by them, and done speedily, the reasonable apprehension is that they will be beaten in the economical laying out of their work as well as in its symmetry, truth, and intricacy. The author sets out with a classification of metal-plate work, and the classes are three in number. Class one is of patterns for articles of equal taper or inclination, as pails, oval teapots, gravy strainers, etc.; and the class has these subdivisions, namely, those of round surfaces, of plane or flat surfaces, and of curved and plane surfaces combined. Class two is of patterns of unequal taper or inclination, as baths, hoppers, cannister-tops, etc.; and the class has like subdivisions with the other. Class three is of patterns for miscellaneous articles, as elbows, and of articles of compound bent surface, as vases, aquarium stands, mouldings, etc. These articles of the different classes and subdivisions are separately dealt with in the volume; and it should be mentioned that the setting out of patterns in sheet metal work belongs to that department of solid geometry known as development of surfaces. This development means the spreading or laying out without rupture the surfaces of solids in the plane or flat, the plane being sheet metal. The introductory problems, with their applications, are preceded by definitions, which may be readily followed by ordinary intelligence, provided it is sustained by application. The concluding pages deal with the metals mostly in use by metal-plate workers, and with alloys and solders, and other technicalities. It is a systematic and thoroughly practical guide for workers in the subject of which it treats.

The October number of the *Journal of Microscopy and Natural Science*, opens with a paper on the "ivy-leaf toad flax," or Linaria cymbalaria. Popularly, this little wild plant bears the names of "roving sailor" and "mother of thousands." It is a native of Italy, but is said to thrive anywhere. Still it may be troublesome to find anywhere, as was the experience of the writer, Mr. R. H. Moore, who, in considering the corolla, searched in vain for a single flower in all the Bath localities known to him. He was in consequence obliged to resort to slides and drawings. This corolla is almost identical in shape with that of the garden, or wild snapdragon, with, however, a distinct spur or nectary, which is wanting in the flowers of the ordinary snapdragon. The lips of the corolla are closely set with a palate of beautiful orange-coloured and silvery hairs, which lie close together. The organs of fructification, within the corolla, occupy a position opposite to the hairs. The leaves of the fully-grown plant are quinquangular in shape, seated on long foot-stalks, the upper surface a dark, shining, green colour, and the under surface a metallic grey. The cuticle of the leaves, the stomata, and the roots are also described. The paper on the photomicography of histological subjects, by Dr. King, of Amoy, China, contains matter of permanent interest, and, as a whole, the paper will be instructive to those interested in this particular research. "Puzzles in Palæontology," by Mrs. Alice Bodington; "The Structure of Flowers with reference to Insect Aid in their Fertilisation," by W. G. Wheatcroft; and "The Microscope, and How to Use it," by V. A. Latham, T.M.S., complete a series of more than common merit.

*The Journal of the Society of Chemical Industry* reproduces among its communications three of the papers read before the 1887 Manchester British Association meeting. These papers are those of Professor G. Lunge, of the Federal Polytechnic School at Zurich, on the composition of some coke oven tars of German origin; of Mr. Watson Smith, lecturer on chemical technology in the Victoria University, on the composition of the blast furnace tars from the Eastsherne iron works; and of Dr. Constantin Fahlberg, on saccharine, the new sweet product from coal tar. There is another paper by Professor Lunge on a new apparatus for condensing gases by contact with liquids. The new apparatus, which is fully described, is styled the "plate column," because its essential feature is the perforated plates with which it is filled. The "plate column" is various in shape and may be constructed of any suitable material, but so far it has only been made of the stoneware which is the speciality of Mr. Rohrmann. The form now preferably made consists of a number of earthenware cylinders of as large diameter as can be conveniently made, the bottom being a trough surmounted by one or more cylinders with the perforated plates within, and having, together with an outlet for the gas, an arrangement for spreading the condensing fluid. The selections under the head of journal and patent literature are, as usual, ample and well chosen.

*Calvert's Mechanics' Almanack* and workshop companion is a well-known, practical, technical, and industrial compilation. Various short papers by named writers have a place among the pages, one on workshop rectitude, by William Fletcher, being the first. Mr. Fletcher thinks that were we to give up sizing cotton with clay and other substances, and generally to become honest in representation, production, and distribution, there would be less reason to complain of trade depression. A paper read by Mr. T. Pridgin Teale, M.A., at the Parkes Museum of Hygiene, Margaret Street, W., on economy of fuel in house fires, is reproduced as the second named paper. Mr. Teale's contention is, "that every fireplace should make its own gas and burn it, and its own coke and burn it." The diagrams which illustrated the lecture are not reproduced.

## SCIENTIFIC MEETINGS AND EXHIBITIONS.

VIENNA INDUSTRIAL EXHIBITION.—An industrial exhibition will be held in Vienna next year, to celebrate the fortieth anniversary of the accession of the Emperor to the throne. In connection with this there will be published statistics showing the improvement in the social condition of the industrial population which has taken place during that period.

KING'S COLLEGE.—A course of about eighteen lectures on "Agriculture" will be delivered during the ensuing winter session at King's College, London, by Mr. Frederick James Lloyd.

CITY AND GUILDS OF LONDON INSTITUTE.—The following is a list of the winners of the various scholarships and studentships recently competed: Holt Scholarships—P. R. Jones, Middle-Class School, Cowper-street, E.C. Saddlers' Company's Studentships—W. E. Allen, United Westminster Schools, previously educated at St. Thomas' Charterhouse School. Mitchel Scholarships—T. W. M. Bull, F. Gaywood, F. H. Hammel, J. J. Nisbet, all of the Middle-Class School, Cowper-street.

TECHNICAL EDUCATION IN THE BORDER BURGHS.—In Hawick, Galashiels, and Selkirk, instruction has been given for some years past, during the winter months, on scientific subjects as applied to the art of cloth manufacture. Lectures have also been delivered on the various processes employed in the manufacture of cloth. In Galashiels the classes are conducted under the auspices of the Galashiels Manufacturers' Corporation, and they may now be looked upon as a permanent institution in the town. The manufacturers are fully alive to the wants of the community, and they have shown themselves to be abreast of the times in this important matter of technical and scientific education.

STOKE INDUSTRIAL EXHIBITION.—The Finance Committee have issued a circular appealing for subscriptions to the Guarantee Fund, in which, after setting forth the objects of the proposed exhibition, it is stated that neither at Birmingham, Wolverhampton, nor Worcester was one penny of the Guarantee Fund required, and that the exhibitions in those centres have been much on a par with that projected for this district. The leading manufacturers and traders of North Staffordshire will certainly exhibit a lack of spirit and enterprise if the minimum sum of £10,000 be not readily forthcoming, as otherwise, according to a resolution passed at their last meeting, the committee will decline the responsibility of proceeding.—*Industries.*

NEWTON ABBOT SCIENCE SCHOOLS.—Under the auspices of the committee of the Newton Abbot Science and Art Schools, Sir Samuel Baker has delivered a public address on Science and Art Education. Several additional donations were announced at the meeting towards the payment of the debt which still encumbers the schools to a moderate extent.

SOCIETY OF CHEMICAL INDUSTRY.—The meeting of November 7 will be for Mr. C. T. Kingzett's note on the comparative antiseptic action of chlorides, nitrates, and sulphates; and for the discussion on Mr. John Ruffle's paper on the correct analysis of superphosphates, plain and ammoniated.

IPSWICH SCIENTIFIC SOCIETY.—At the last monthly meeting it was decided to hold a conversazione on the 29th November at the public hall, and members are requested to communicate with the hon. sec. as to any exhibits they may wish to supply. Attention will be given to maram grass as affected by ergot, and to animal wax as formed in Irish peat bog by the decomposition of animal remains. The principal business of the monthly meeting was a paper on colour, illustrated by experiments, which was read by Mr. S. A. Norbcutt.

LIVERPOOL ENGINEERING SOCIETY.—The programme for the ensuing session is, on Nov. 2, automatic weighing, by Mr. H. Pooley, jun. On Nov. 16, a paper by Mr. R. L. Tapscott, Assoc. M. Inst. C.E. On Nov. 30, a paper by Mr. J. A. Sauer, Assoc. M. Inst. C.E. On Dec. 14, an address by the retiring president, Mr. John J. Webster, M. Inst. C.E. On January 11, on the filtration of water, by Mr. A. W. Brightmore, M. Sc.

PARIS EXHIBITION OF FIRE EXTINGUISHING APPLIANCES.—An International Exhibition of inventions and systems for preventing or extinguishing fires in theatres is to be opened on November 25, in the Municipal Pavilion in the Champs Elysées, Paris. There are to be theatrical performances with sham fires.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS, *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

11900.—ARTHUR JOHN SHANNON, 55, Wood Lane, Shepherd's Bush, W.C. "Extraction of antimony from its ores." 2nd September, 1887.

11906.—JAMES BUDD, 33, Peckham Grove, Camberwell. "Crystallisation of glass." 2nd September, 1887.

11945.—HENRY AUGUSTUS ROWLAND, 1, St. James' Square, Manchester. "Casting of metals" 3rd September, 1887.

12019.—HERMANN HARTIG, 6, Bream's Buildings, Chancery Lane, London. "Electro-magnetic motors." (Complete specification.) 5th September, 1887.

12037.—JOHN LOUIS CANTELO, 154, Selborne Street, Liverpool. "New or improved type writer." 6th September, 1887.

12040.—HENRY SKERRETT, Great Western Chambers, Livery Street, Birmingham, Warwickshire. A communication from John Henry Dalzell, United States. "Manufacture of electric cables and in means or apparatus to be used in the said manufacture." (Complete specification.) 6th September, 1887.

12048.—EDMUND KELLY IRWIN, 66B, Cottage Grove, Stockwell, London. "Railway train self-signalling apparatus." 6th September, 1887.

12055.—ANDREW MILLS and CHARLES EZRA CONVIS, 77, Chancery Lane, London. "Rotary drivers." (Complete specification.) 6th September, 1887.

12060.—STEPHEN WILLINGTON, 6, St. Paul's Churchyard, London. "Means for the hydraulic propulsion and steering of vessels." 6th September, 1887.

12076.—JOHN SHEPHERD SAWREY, GEORGE LEE ANDERS, and HAROLD COLLET, 47, Lincoln's Inn Fields, London. "Electric telephones especially adapted for domestic and office use. 6th September, 1887.

12078.—ROBERT ADOLF GROSS, 1, Queen Victoria Street, London. "Production of an artificial constructive or ornamental raw material." 6th September, 1887.

12087.—EPAPHRAS SEAGE, FREDERICK SEAGE, and FREDERICK FREEBY REID, 33, Howell Road, Exeter. "Working an engine or motor by a chemical compound, and so forming a chemical compression engine." 7th September, 1887.

12091.—FRANCIS B. WELCH, Manchester Chambers, Market Street, Manchester. "Pneumatic tubes and the necessary apparatus for the same." 7th September, 1887.

12110.—JAMES LOGAN WATKINS, 6, Warbeck Road, Uxbridge Road, London, W. "The attachment to signal lamps of either a gong, whistle, detonating cap, or fog horn." 7th September, 1887.

12130.—ALBERT GARDNER CLOAKE, 94, Ferme Park Road, Hornsey. "Telephone for conducting sound more audibly for a further distance." 7th September, 1887.

12166.—HAROLD KINGCOMBE READ, 25, Macfarlan Road, Shepherd's Bush. "Appliances for making, and breaking, and protecting an electric circuit." 8th September, 1887.

12190.—HENRY HARRIS LAKE, a communication from Eugene Emmons Graves, United States. "Telephonic apparatus." (Complete specification.) 8th September, 1887.

12200.—WILLIAM MUSGRAVE, 4, Mansfield Chambers, 17, St. Ann's Square, Manchester. "Arrangement of Corliss valves for motive-power engines." 9th September, 1887.

12203.—THOMAS LYNCH HEMMING, 11, Old Square, Birmingham. "Dynamo-electric machines." 9th September, 1887.

12208.—SYDNEY FERRIS WALKER, 195, Severn Road, Cardiff. "Electro magnets." 9th September, 1887.

12219.—JOSEPH HENRY SAMS and LA MARCUS ADNA THOMSON, 323, High Holborn, Middlesex. "Improvements in Car Wheels." (Complete specification.) 9th September, 1887.

12230.—JOSEPH TAYLOR, 6, Dowgate Hill, Cannon Street. "Electro magnets." 9th September, 1887.

12252.—ROBERT PERCY SELLON, 47, Lincoln's Inn Fields, London. "Dynamo-electric machines." 9th September, 1887.

12253.—ROBERT PERCY SELLON, 47, Lincoln's Inn Fields, London. "Electrical transformers." 9th September, 1887.

12313.—HANS PETER FREDERICK JENSEN, 21, Finsbury Pavement. "Electric and magneto-electric bells, indicators, and other apparatus used in connection therewith." 10th September, 1887.

12338.—WILLIAM FORDYCE, 115, St. Vincent Street, Glasgow. "Anti-fouling composition for ships' bottoms and other submerged surfaces." 12th September, 1887.

12371.—GEORGE ALEXANDER CALVERT, 87, St. Vincent Street, Glasgow. "Screw propellers." 13th September, 1887.

12385.—JAMES DAVIS BURTON, 77, Colmore Row, Birmingham. "Calculating machines." 13th September, 1887.

12406.—ALFRED JULIUS BOULT, a communication from James Francis McLaughlin, United States. "Electrical type-writers." (Complete specification.) 13th September, 1887.

12415.—FREDERICK CARRINGTON PHILLIPS and HUGH ERAT HARRISON, 2, Victoria Mansions, Victoria Street, Westminster. "Electric switches." 13th September, 1887.

12419.—SEBASTIAN ZIANI DE FERRANTI, 24, Southampton Buildings, London. "Electric railways." 13th September, 1887.

12424.—EMIL DANIEL MULLER, 45, Southampton Buildings, London. "Explosive compounds." 13th September, 1887.

12456.—WALTER HIBBERT, 8, St. Dunstan's Road, West Kensington. "Electrical measuring instruments." 14th September, 1887.

12542.—THOMAS CHRISTOPHER LEWIS, 6, Bream's Buildings, Chancery Lane. "Electrical storage batteries." 15th September, 1887.

12553.—EDWARD TILSTON and WILLIAM HENRY NIXON, New Bridge Street, Manchester. "Spinning or twisting fibres or yarns." 16th September, 1887.

12556.—ALEXANDER MACLAINE, 1, Queen's Elms, Belfast, Antrim. "Heating, increasing, and regulating the supply of feed water in connection with steam engines." 16th September, 1887.

12565.—ALEXANDER BUTLER ROWLEY and JACOB FIELDING, 4, St. Ann's Square, Manchester. "Warp-dressing machines." 16th September, 1887.

12571.—FREDERICK HENRY GOTTLIEB and EDWIN ATKINSON WHITEHEAD, 1 Sundorne Road, Charlton. "Collecting and separating dust in grinding or other mills." 16th September, 1887.

12635.—WILLIAM LOWRIE and CHARLES JAMES HALL, 433, Strand, London. "Electricity meters." 17th September, 1887.

12636.—LEWIS EMERSON BATHRICK, Somerset Chambers, 151, Strand, London. "Means for dissipating electricity for printing machines." (Complete specification.) 17th September, 1887.

12676.—WALTER THOMAS GOOLDEN and LLEWELYN BIRCHALL ATKINSON, 23, Andalus Road, Clapham. "Dynamo-electric generators and motors." 19th September, 1887.

12683.—FRANCOIS MARIE ARTHUR LAURENT-CELY, 169, Fleet Street, London. "Manufacture of spongy lead suitable for electrical accumulators." 19th September, 1887.

12714.—GUSTAVE GILLMAN, 150, Cromwell Road, South Kensington, London. "Developing and fixing photographic negatives and positive prints." 20th September, 1887.

12718.—JAMES TATE, Sunbridge Chambers, Bradford. "Electrical speed indicators." 20th September, 1887.

12747.—ALFRED JULIUS BOULT. A communication from Elias E. Ries, United States. "Welding and tempering metals." (Complete specification.) 20th September, 1887.

12763.—GEORGE FORBES, 34, Great George Street, Westminster. "Electric meters or apparatus for measuring electricity." 20th September, 1887.

12824.—ALEXANDER MCEWEN. A communication from Cuthbert George McEwen, South Africa. "Improved system of electrical distribution." 21st September, 1887.

12829.—HIRAM POTTER TALLMADGE, 45, Southampton Buildings, London. "Furnace grates provided with movable fire bars." (Complete specification.) 21st September, 1887.

12830.—WILLIAM ROBERT LAKE. A communication from Otto Heinrich Louis Lindemann, Germany. "Electric lamps or lighting apparatus." 21st September, 1887.

12844.—ARTHUR ALEXANDER GOVAN, 101, St. Vincent Street, Glasgow. "Apparatus for automatically raising and lowering the lights in railway or other carriages." 22nd September, 1887.

12852.—WILLIAM PHILLIPS THOMPSON. A communication from James Dunstan, United States. "Safety catches or attaching apparatus applicable for use on rope-hauling railways." 22nd September, 1887.

12865.—HERBERT JOHN HADDAN. A communication from James M. Whitney, United States. "Rotary engines." 22nd September, 1887.

12867.—GEORGE SPARROW and WILLIAM SAMUEL KELLY, 46, Lincoln's Inn Fields, London. "Folding bath for use at the side of a ship, pontoon, or other floating structure." 22nd September, 1887.

12878.—ALEXANDER DUNCAN MARSHALL, 45, Southampton Buildings, London. "Automatic steam-trap." (Complete Specification.) 22nd September, 1887.

12885.—GUSTAVE EUGENE CABANELLAS, 45, Southampton Buildings, London. "Dynamo-electric or magneto-electric machines." 22nd September, 1887.

12887.—WILLIAM PHILLIPS THOMPSON. A communication from A. Schneider and Co., France. "Hardening or tempering of steel or steely iron." 23rd September, 1887.

12894.—JOHN ANDERTON, 142, Suffolk Street, Birmingham. "Instrument to show the focus of convex and concave lenses." 23rd September, 1887.

# Scientific News

## FOR GENERAL READERS.

Vol. I.] December, 1887. [No. 10.

CONTENTS.



## CURRENT EVENTS.

The Utility of Scientific Work.—In his admirable address to the medical students at the Owens College, Manchester, Sir James Paget laid great stress on the utility of scientific work in the practice of medicine and surgery. As will be seen from our abridgment elsewhere, most of his remarks are just as applicable to those engaged in other kinds of work based on or connected with different branches of science. It is seldom, indeed, that we have read a more useful, and at the same time a more thoroughly high-minded address, and we make no apology for giving elsewhere lengthy abstracts from it. We commend it to all, scientific or otherwise, for whoever reads it must be the better for it. Sir James mentions, incidentally, that a misleading distinction is often made in speaking of the scientific part of a student's training as opposed to his more practical work, as though it were implied that the studies which are called scientific are not useful.

He also points out that the main thing for progress and self-improvement is accurate observation, and that this involves habitual watchfulness of all the conditions in which objects or events are found. Often, indeed, we think ourselves observant when, in fact, we have the habit of inserting something of our own, something of our beliefs, of our expectations, nay, even of our wishes, into that which we think or say we observe. "We expect facts or events to agree with what we believe that we know, and we make light of the differences and exaggerate the likenesses; we take no thought of what we call accidental exceptions; we think them unmeaning—as if anything in nature could be without meaning—and we do not half observe them." The personal equation is no doubt always a difficulty, and must be carefully guarded against; and Sir James Paget does well to emphasise the fact. Often, indeed, facts have been long and strangely overlooked which would have led to the making of discoveries years before they were actually arrived at.

Cremation.—According to a contemporary, Sir Spencer Wells, in his Nottingham address on cremation, dwelt upon an aspect of the question which has been a good deal neglected—namely, the tendency of inhumation to preserve the germs of specific diseases, impregnating the soil and rendering it poisonous for an indefinite number of years. Here he might very fitly have mentioned that in Brazil cremation is now legally compulsory during epidemics of yellow fever. He gave, as an instance, an outbreak of scarlet fever caused by the reopening of a burial place used during an epidemic of that disease thirty years before; and he pointed the moral by telling his audience that during the last three months the bodies of 476 scarlet fever patients had been buried around London—"some 50,000 lb. of animal matter, charged with myriads of parasitic organisms, which may retain their vitality for many years." He reminded his hearers that there exists no legal objection to cremation; he met the religious objection by the saying of Lord Shaftesbury, addressed to himself, "What has become of the Blessed Martyrs?" and he argued that the sentimental objection would be overcome as soon as people realize "what a revolting change takes place after burial in the bodies of those they have loved." The address may fairly be called a nail in the coffin of inhumation.

The Phylloxera.—The war against the phylloxera still goes on, though without any decisive success. France has suffered more from these small insects than she did from the German invaders, and the end is not yet. Nostrum after nostrum is tried with partial success and is again abandoned. The latest device we meet with is that of Dr. Clemon. He mixes with the soil of the vineyard sulphides and carbonates which are easily decomposed, and by preference those of potash. He then introduces a quantity of peat which has been previously allowed to absorb sulphuric, nitric, or phosphoric acid. Any of these acids gradually acts upon the above-mentioned sulphides and carbonates, and sets free sulphuretted hydrogen and carbonic acid. These gases pervade the soil, and according to the experiments of Dr. Eyrich destroy not merely the phylloxera in its subterranean stage, but other vermin. The potash, of course, remains in the soil as a sulphate, a nitrate, or a phosphate, all of which, especially the two latter, are valuable manures. Thus the soil of the vineyard is enriched and freed from vermin at a stroke. We can only hope that this process may prove successful when carried out on the large scale.

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Scientific Instruction.—At the annual distribution of prizes to the students of the Newcastle Grammar School, Sir Lowthian Bell made some very useful remarks on the subject of technical instruction for artisans. He is strongly of opinion that we should seek to obtain greater skill on the part of our workmen; at the same time he is by no means enamoured of the idea of introducing mechanical tools into our schools, as he considers the workshops the proper place for acquiring this knowledge. He urged, however, the necessity for more science teaching, not because a young man on leaving school would then have learnt enough science for his future life, but because his attention would then be directed to science in a way that no other mode of procedure would do. He felt sure that if our lads were instructed in the first elements of scientific knowledge while they were at school, when turned into workshops or chemical manufactories, they would in one week learn ten times as much of the business to which they devoted themselves as they would in ten years in a school by the introduction of mechanical tools. The latter system, he considered, would only distract their attention from those branches of study to which they ought to apply themselves, and in this opinion he was fortified by every inquiry he had made on the subject.

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Sir Lothian Bell also very properly insisted on the need for accuracy in all branches of work, and in support of this he gave some very interesting particulars of what is now accomplished with spinning machinery. A spinning mule, he said, may have 91,000 spindles, and these 91,000 spindles can spin in the year cotton yarn representing a length of 67,382,000 miles. That is to say, that in eighteen months such a mule would be able to spin a length of cotton yarn which would reach from the earth to the sun. The mule also has to travel backwards and forwards while the spindles are running at very high speeds, and it would be quite impossible to insure this being done with perfect regularity unless the machinery were made with the greatest possible precision.

Books as Vehicles of Infection.—That books, in common with paper of all kinds, are fine mediums for absorbing and retaining infectious matter, has long been admitted. But its practical recognition for, we believe, the first time, is due to the Town Council of Sheffield, who have closed the lending department of the Free Public Library in their town until the epidemic of small-pox now prevailing there shall have subsided. This precaution, however, will be but imperfect unless all other lending libraries in the town are closed in like manner. Whether this is within the legal powers of a corporation we, of course, cannot decide. The distribution of tracts is another channel through which zymotic disease may be easily propagated.

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Artificial Glucose.—We learn that Dr. E. Fischer and Dr. Julius Tafel, of the University of Würzburg, have succeeded in the artificial preparation of glucose, otherwise known as starch-sugar. The raw material appears to be acrolein, that well-known volatile and irritating compound which diffuses itself through the house when cook lets a red-hot cinder fall into the dripping-pan. But on the large scale acrolein is best obtained from glycerine. We are not sanguine as to the industrial prospects of the new invention, since glucose is now being prepared from potatoes, maize, etc., at a price much below that of glycerine.

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The Constitution of the Heavenly Bodies.—A paper read by Mr. Norman Lockyer before the Royal Society on the 17th ult., contains views which if ultimately substantiated must initiate a new epoch in the science of astronomy. He holds that all self-luminous bodies in the heavens are composed of meteorites or masses of meteoric vapour, produced by the heat evolved by the condensation of meteor swarms due to gravitation. The meteorite is, so to say, the starting-point of the universe. The spectra of all bodies depend upon the heat of the meteorites produced by collisions, and varying almost infinitely. If collision takes place when two bodies are moving at the rate of one mile per second, the temperature generated will be about 3,000° Centigrade, a temperature double that at which pure iron melts; whilst if the bodies are moving at the rate of 60 miles per second —a velocity perfectly possible—the heat produced would be 10,800,000° Centigrade, a temperature absolutely inconceivable.

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Stars like Sirius represent an ultimate stage of the process of the condensation of meteorites; and here the highest possible temperature is reached. A cooling stage is shown in our sun, whilst the stars of the third class have cooled down to temperatures no longer transcendental and capable of approximate reproduction by artificial means. The heavenly bodies may be arranged on the two arms of an ascending and descending curve. At the foot of the former branch are meteorites, then nebulæ, comets, and stars in different stages of condensation. At the summit we find bodies like Sirius, and on the descending limb stars like our sun, and dimmer ones down to bodies no longer luminous. At an early date we shall endeavour to lay before our readers a more complete exposition of Mr. Lockyer's researches.

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TECHNICAL EDUCATION.—At a recent conference of the friends of technical education, Professor Silvanus Thompson expressed his deep regret that in many institutions for technical education the leading principle was not to supply a training required for practical purposes, but to earn grants under the conditions prescribed by the Science and Art Department at South Kensington. That department had drawn up a syllabus of twenty-five subjects called "Science subjects," and refused to recognise even the existence of any science teaching that does not fit to their artificial classification. Optics is not a science unless taught with heat and acoustics. Heat is not a science unless taught along with optics and acoustics. Teaching about the steam-engine is science; but teaching about the gas-engine or the electric-motor is not. There is a Government grant for teaching the one; there is none for teaching the other.

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Among illustrations of the resultant absurdities, he noted the case of an accomplished engineer and draughtsman who had served his time in the great firm of Maudslay, and who had occupied every post in engineering works up to manager, who was disallowed as a teacher of machine construction and drawing because he had never passed the South Kensington examination, whilst at the same time any Board-school teacher who had passed that examination was recognised as competent to teach, though he might never have been inside an engineer's drawing-office in his life. According to Professor Thompson, the Technical High School of Berlin has been built at a cost, including the land, of nearly a million sterling, and is maintained by an annual grant exceeding the cost (£35,000) of erecting Finsbury College. He might have added that in the Berlin High School, and in other similar institutions in Germany, the teachers are not paid on the fatal system of "results."

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DARWIN'S LIFE.—After a hurried perusal of the book of the season, the leading thought on one's mind is that great good will be done by spreading the knowledge of Darwin's real character. The unadorned record of his daily life affords at once an example of extraordinary industry under most adverse circumstances, and a lesson of self-control during years of painful illness which we shall all do well to bear in mind. For about forty-five years he was never twenty-four hours without pain and discomfort, and he was unable to do more than three hours' work a day. Often he was not able to work at all, and yet he was in no way embittered, but was always cheerful and considerate, not only to his immediate friends, but even to those strangers who intruded upon him with troublesome letters and complaints about the theories he had advanced. All who have read his books have been struck with his surprising industry and candour, and these characteristics are fully confirmed by the letters and incidents now made public.

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With his usual simplicity, he appears to have told Mr. Francis Galton, in answer to an inquiry as to what were his peculiar merits, that "he had none whatever." At the same time he admitted that, in his opinion, "all he had learnt of any value had been self-taught." His school career was by no means promising, and his father almost despaired of making anything good of him. He began to study medicine, but could not stand operations, and, as a *dernier ressort*, he was sent to Cambridge to prepare for the Church. Fortunately for the world, he was allowed to sail in the *Beagle*, and during a five years' voyage he was not only busily employed in collecting specimens and information, but his own education was greatly advanced. He returned with a mind stored with knowledge and teeming with new ideas, to which, however, he only gave expression after many years' exhaustive inquiry. We commend the study of his life to all who care for what is best in man.

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THE LIGHT OF THE GLOW-WORM.—The following singular experiment is recorded in the *Moniteur de la Photographie* of Paris. People have long wondered whether the light of the glow-worm and other luminous animals, which is due to the secretion of a substance called noctilucine, possesses any chemical action or not. In order to decide this question, a small square cardboard box, having at the bottom a little plate of highly sensitive bromated gelatine, and a lid perforated with a number of minute apertures, was placed in a dark cupboard, and upon the lid a female glow-worm, *Lampyris noctiluca*, was secured by means of an inverted tumbler. The insect was highly luminous, and it was allowed to crawl about over the perforations in the lid of the box for the whole of the night. At the end of that time the sensitive plate was taken out and developed in the dark room in the ordinary manner. An image was thus obtained, consisting of a series of minute circular discs, corresponding to the perforations in the lid of the box, and to the movements of the insect during the time it was confined in its temporary prison. Here, then, we have a photograph produced by the glow-worm itself, proving that the light emitted by the noctilucine secretion is endowed with chemical activity like the light of the sun or the electric light. This curious experiment supplies another argument in favour of the theory that the light of the glow-worm is due to a chemical action consisting in the oxidation of the noctilucine produced by the insect.

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DR. OCTAVIUS STURGES, of Emmanuel College, Cambridge, has been appointed Assessor to the Regius Professor of Physics.

MR. WILLIAM BATESON, B.A., Fellow of St. John's College, has been elected to the Balfour studentship of the annual value of £200, and tenable for three years. The student is required to devote himself to original biological research.

## GENERAL NOTES.

Oil on the Troubled Waters.—M. de Lesseps gives an instance, where a vessel in the Bay of Talcahuano, attacked by a tempest from the south which lasted ten days, rode out the storm without damage by means of oil-bags.

The Deepest Wells and Mines.—The deepest well is at Schliedenbach, Prussia; it is 4,300 feet deep. The deepest mine in Great Britain is the Rose Hill Colliery, 2,445 feet deep; and a mine at Andreasberg, in the Hartz Mountains, is 4,500 feet deep.

Petroleum Fuel —Experiments are being made at Chicago with crude petroleum for firing boilers, and a great saving is thereby expected. The boilers are being arranged in such a way that coal fuel can, in case of need, be resumed almost without letting steam down.

To Protect Screws from Rust.—For the protection of iron screws against rust, it is recommended to dip them before use in a mixture of oil and graphite (black lead). This simple method not only prevents rusting, even in damp wood-work, but renders their insertion much easier.

Cholera and Typhoid Fever.—At the last meeting of the Sanitary Institute of Great Britain, Dr. G. V. Poore maintained that the epidemics of cholera and the modern development of typhoid fever in England are probably direct results of the domestic arrangements now in general use.

The Decomposition of the Elements.—Professor A. Grunwald, in a profound and elaborate memoir, argues, on mathematic-spectroscopic grounds, that our so-called elements are composed of much simpler ingredients. A part, at least, of his results have received experimental verification.

The Industries of Bolivia.—The chief productions of this country, much of which is still unexplored, are ores of copper, silver, and tin. The richer silver and tin-ores are exported to Europe, whilst the poorer qualities are worked on the spot. The principal vegetable products are Peruvian bark and coca.

Origin of Scarlet Fever.—M. Pickeney, in the *Comptes Rendus*, gives a case which strongly confirms the view that scarlatina has its origin in cows, and is communicated to human subjects by their milk, one person being then capable of infecting others. He insists that milk should always be boiled before use.

Vitality of the "Germ" of Pulmonary Consumption.—Dr. Gautier has recently called attention to the wonderful vitality of the bacillus of tubercle. It resists cold, desiccation, and disinfectants, so that there is no known means of purifying the bedding, curtains, etc., of a room occupied by a consumptive patient.

Gall of Lavine.—This is a new yellow colouring matter, obtained by the oxidising action of the air upon an alkaline solution of gallic acid. It dyes shades ranging from greenish yellow to orange, and is fixed by means of the same mordants as those employed for alizarine. It is permanent to light, air, and soap.

Researches on Drainage.—M. Berthelot, in a memoir communicated to the French Academy of Sciences, proves that the nitrogen removed from fields in the shape of drainage-water is from twenty-four to twenty-six times greater in quantity than that which is brought down to the same fields in the rain.

Meteorology in Japan.—The Mikado of Japan has issued an Imperial Decree sanctioning the establishment of meteorological observatories at the public expense. The regulations provide that the Central Observatory shall be situated in Tokio, and local observatories at such places as the Home Minister may designate.

Sea of Galilee.—The fish in this lake have lately been classified, and prove to belong to the species peculiar to the African lakes, so it is suggested that the Jordan Valley in long past ages must have been filled by a lake joining the Red Sea, which was then probably a fresh-water lake communicating with the great lake system of Central Africa.

The Struggle for Existence.—Professor Metschinkoff holds that the diseases occasioned by the penetration of parasitic micro-organisms into the living body mean an intercellular war between these intruders and the elementary cells of the organism. On the result of this war depends the life or death of the man or other animal.

The Fauna of the Azores.—M. Jules de Guerne, after a close examination of the islands Fayal and San Miguel, finds that the fresh-water Fauna of the Azores, generally considered as nearly null, includes a considerable number of species belonging for the most part to types which have great facilities for dissemination. This fauna possesses a continental and even European character. These islands also possess peculiar terrestrial forms, especially crustaceans and mollusca.

A Posterior Eye.—General experience proves that the organs of special sense, and above all of sight, are placed in the head or anterior extremity of animals. But MM. H. de Lacaze-Duthiers and G. Pruvot, in a paper read before the French Academy of Sciences, state that there exists a very large eye at the posterior extremity of the larvæ of certain Opisthobranchial Gasteropods. This is a striking exception to a supposed general rule, but it does not "prove the rule."

Compressibility of Water, Mercury, and Glass.—At a recent meeting of the Edinburgh Royal Society, Professor Tait communicated some results on the compressibility of water, of mercury, and of glass. The average c mpressibility of a 20 per cent. aqueous solution of common salt per atmosphere for the first 100 atmospheres is 0·0000316. It diminishes rapidly with the percentage of salt in solution. The compressibility of common lead glass is 0·0000027 at a temperature of 19° C.

Endosmose, Dialysis, and Osmose.—M. Leplay has pointed out a clear distinction between these three processes, which are often confounded together. Dutrochet's endosmose depends on the tendency of two fluids of different densities, separated by a membrane, to equalise such densities; Graham's dialysis consists in the tendency of two fluids differing both in density and composition to equalise themselves in both respects, especially in the latter; Dubrunfaut's osmose, on the other hand, seeks to hinder the production of an equilibrium.

Aluminium Steel.—A large number of steel companies are experimenting with aluminium to produce sound castings. Among them are the Cleveland Rolling Mill Company, the Lindon Steel Company, the Pittsburgh Steel Casting Company, the Otis Steel Company, the Alliance Works, and the Chester Works. They use an alloy of iron and aluminium, manufactured at Lockport, N.Y., by the Cowles Electric Smelting and Aluminium Company, cast in thin slabs, and carrying from 5 to 10 per cent. at a cost of 4 dols. per pound of the aluminium contained.—*Railroad Gazette.*

The Purity of Soap-Powders.—For this purpose a very simple method has been given, which requires neither chemical skill nor the appliances of a laboratory. It is merely necessary to put about 15 grains of the sample into a narrow phial of clear glass, and pour upon it rather more than half a fluid ounce of a mixture of 85 parts of alcohol and 15 parts of acetic acid. If the solution be clear the soap-powder is pure. If there be an effervescence an excess of soda in some form is present, and if there remains a sediment undissolved the sample contains steatite, kaolin, or other soapy minerals.

Nickel Crucibles.—It is well known that pure nickel is one of the toughest of metals, and that it fuses only at a very high temperature. It has a very fine grain, takes a high polish, and is very compact and unalterable. These qualities have led to its being employed for crucibles and evaporating dishes. They stand the action of alkalies remarkably well. Cold hydrochloric acid, whether dilute or concentrated, may be used to clean out these crucibles, and no alteration in weight is the result. Cold oil of vitriol is likewise without action; but concentrated nitric acid attacks them, causing rapid loss of weight.—*Horological Journal.*

The North-East Wind.—The most singular feature in this somewhat exceptional year has been, meteorologically speaking, the predominance of the polar current. In most seasons, Kingsley's "mild north-easter" does not persecute us after summer has set in. But this year it has been observed during thirteen days in August, fourteen in September, and fourteen in October—a decidedly exceptional state of things. The occurrence of a temperature of 19° Fahrenheit—or, in other words, 13 degrees of frost—as early as the beginning of October, and in so southern a locality as within six miles of Southampton, is scarcely within the recollection of the public.

Magnetic Filter.—A magnetic filter for cleaning oil which has been used for lubricating machinery has been brought out by the Electric Filter Company of Chicago. The filter consists of a vessel contracted in the middle and surrounded at that point by a coil of wire, through which an electric current is caused to circulate. This portion of the cylinder contains iron filings which are magnetised by the current and thus attract the iron particles and other metallic particles of magnetic tendency. The oil is further clarified by passing through other filters, such as felt cloths and sawdust; and is received in a purified condition in the lower receptacle.

Adulterated Flour.—Adulteration of flour by potato flour may be detected by means of acids. Take a spoonful of flour and pour upon it a little nitric acid; if the flour be of wheat, the colour will be changed to an orange yellow; if wholly of potato flour, the colour will not be altered, but the flour formed into a tenacious jelly. If, therefore, the flour be adulterated with potato flour, it will not be difficult to decide. Again, take a spoonful of the flour, and pour upon it a little muriatic acid; if the flour be of pure wheat, it will be changed to a deep violet colour, without odour; but if potato flour is mixed with it, it will then have an odour like that of rushes.—*Scientific American.*

Colouring Copper and Nickel.—According to the *Journal des Appl. Electriques*, a variety of tints can be produced upon copper and nickel. To do this the articles are thoroughly cleaned and polished, and placed in the following solution: Acetate of lead, 31 grains; hyposulphite of soda, 93 grains; water, 1 quart. The bath must be heated nearly to the boiling point before the copper or nickel articles are placed in it, when a greyish tint is first produced, which changes successively to violet, chestnut brown, red, and blue, including the intermediate shades. When any desired colour is obtained, the articles are withdrawn from the bath, washed, dried, and varnished. This process is especially adapted to the colouring of buttons or similar small metallic articles.

Extermination of Rabbits.—The Government of New South Wales are advertising a reward of £25,000 to any person who will make known and demonstrate at his own expense any method or process not previously known in the colony for the effectual extermination of rabbits. The conditions are:—(1) that after 12 months' trial the experiment shall receive the approval of a Board appointed for the purpose by the Governor; (2) that such method or process shall not be injurious, not involve the use of any matter, animal, or thing which may be noxious to horses, cattle, sheep, camels, goats, swine, or dogs. The Board undertakes not to disclose the particulars of any method or process unless it decides to give the method or process a trial.

Electro-Plating with Aluminium.—Herman Reinbold, in the *Jewellers' Journal*, says a plating bath can he prepared as follows:—50 parts of alum are dissolved in 300 parts of water, and, added to 10 parts of chloride of aluminium, are heated to 200° and cooled; 39 parts of cyanide of potassium are then added. The object to be plated must be clean, and absolutely free from grease. It is then suspended in the bath over the electro-positive electrode, a plate of metallic aluminium being suspended on the negative pole. The electric current should be weak. The deposit, when polished, will be equal to the best silver-plating, having the advantage of not being oxidised or getting black when brought into contact with sulphurous vapours, which would make it especially valuable for plating spoons and table ware.

The Last Alpine Vulture.—According to the *Swiss Journal of Ornithology*, the *Lämmergeier*, or Alpine vulture, may be regarded as extinct in Switzerland. A solitary female specimen dwelt for the past twenty-five years on the Biotschhorn, in the Upper Valais, and escaped countless attempts at capture. But a little time ago, when the severe weather set in, a poisoned fox was left below the cliff, and proved a successful trap, and the bird was found dead. The body was stuffed and placed in the museum at Lausanne; it measured across the wings 2½ mètres, or nearly 88½ inches. Possibly one or two solitary specimens may still linger in remote eyries; but it is quite certain that a nest is not to be found any longer, so that this much-dreaded species may be considered to have disappeared within the Swiss territory.

Temperature of Scottish Lochs.—The Scotch Meteorological Society have found that shallow lochs, such as the

Gareloch, have a temperature which varies quickly with the changing heat and cold of the year, and not differing more than a degree or two from top to bottom; deeper lochs, such as Lochlong, Lochgoil, or Lochfyne, have a bottom temperature which is not at all affected by the changes of the year; and in them also it often happens that the coldest water is not found at the bottom of the deepest part of the loch, where the sun has least influence, but not very far from the surface—water of different degrees of heat lying in layers, the one superimposed above the other. Further, it is found that the degree of saltness varies greatly in these lochs, the deeper lochs having practically the same degree of saltness as the ocean, while the shallow lochs have lost a good part of their saltness.

Roburite.—Probably it is not widely known that roburite is an invention due partially to the action of the Austrian Government, who in 1882 offered prizes for the safest mining explosives. Roburite, carbonite, and securite were three out of twenty which were favourably reported upon, and the former appears to be the most satisfactory, as it is only being introduced into this country after English mining experts have seen the three explosives used in Germany. It is said that underground, both in coal and stone, it gives results equal in power to ordinary blasting gelatine, while there is not so much small coal produced as with gelatine and dynamite. Some experiments made at the Monk Bretton Colliery recently gave the greatest satisfaction. A shot containing only 65 grm. was placed in the stone in the roof, in a 2 in. drill hole, 4 ft. 6 in. deep, and brought down about 4 ft. thickness of very strong stone.

Nickel Steel.—According to the *Manufacturers' Gazette*, nickel steel which is said to require no hardening is being made by the Ferro-Nickel Society. It is composed of soft iron, nickel, manganese metal or an oxide of it, aluminium, wolfram, and ferro-cyanide of potassium. The steel is produced at one melting. After the iron and nickel are melted, the manganese or its oxide and the ferro-cyanide of potassium are added. After a few minutes' time, during which the manganese with the other ingredients are melting, and the reaction is taking place, the mass is stirred with a red-hot rod of graphite, whereupon the aluminium is added, and the stirring is continued for a short time longer. The alloy is well melted again, when it can be cast into any decided shape in the usual way; the precaution being observed to paint the moulds with coal tar free from water and ammonia, and to have them as free from air as possible.

Manufacture of Aluminium.—The Rhine Falls, situated at Schaffhausen, form the largest cataract in Europe. Some twenty miles below the point where it issues from the Lake of Constance, the Rhine, with a width of 350 ft., and an average depth of about 21 ft., plunges over a barrier of rocks varying in height from 45 ft. on the right bank to about 60 feet on the left. Including the rapids the total fall, within a distance of a little over a third of a mile, is estimated at 150 feet. The volume of water passing over the falls per second varies from a *minimum* of 118 cubic mètres in February to a *maximum* of 502 cubic mètres in July, when, in consequence of the melting of the snows in the mountains and the rise in all the tributary streams and brooks, the Rhine reaches its highest point. An application has recently been made for a concession to utilise these magnificent falls for the manufacture of aluminium, for which it is estimated that 1,500 horse-power are required.

Electrolysis of Sulphites.—Mr. R. Kennedy has converted sulphite of ammonia, obtained by mixing blast gases with sulphurous acid gas in a tower through which water percolated, into sulphates by electrolysis. This was done in the following manner:—Carbon blocks in porous pots were used as cáthodes. These were placed in tubs and surrounded by carbon blocks used as anodes, and a large current from a dynamo was turned on. At the end of an hour sulphur began to form at the bottom of the anode vessel, and in an hour-and-a-half no trace of sulphite remained, the whole having been completely oxidised to sulphates. The curious result was the formation of pure sulphur, and from this it was concluded that the conversion took place partly by the sulphites dropping sulphur, and partly by taking up oxygen at the anode. After the successful conversion of the sulphites into sulphates by electrolysis the liquor was filtered to secure the sulphur and then boiled down to crystallise the sulphates. Experiments made on a larger scale proved that this mode of recovering ammonia in the form of sulphate was cheaper and better than the sulphuric acid and lime process, and that it might be adopted profitably by gas as well as by iron works.

Effects of Lightning on Railway Signals.—The effect of lightning on electrical apparatus of all sorts is a subject on which accurate data seem rather scarce, and its effect on railroad signals especially, is a point on which more light is needed. A cardinal principle in signals which are in any degree automatic, is that they shall show danger in the event of any derangement, and numberless ingenious devices have been invented to provide against the possibility of a signal standing at safety when it has not been intelligently put in that position; but lightning is such a lawless element, and may influence electrical apparatus in so many different ways, that the counteracting of the harm it may do is not an easy task. It may make a ground connection, and thus allow a circuit to appear all right when it is not, being closed at one end, and open (without battery) at the other. It may melt fixtures so as to permanently hold a signal in the position it is in at the moment; and again, it may charge a wire with a current that will actuate the electro-magnets and work the signal, when the signal-man has taken no action whatever. While the chances of the signal being held any length of time in the safety position from the effects of lightning alone are very small, and while it is probable that nearly, or quite all danger in this respect can be guarded against by cautionary instructions to the attendants, it is nevertheless well to make note of all peculiarities noticed, that experience may be compared.—*Scientific American*.

The Electro Deposition of Iron.—Professor W. C. Roberts-Austen, F.R.S., chemist to the Mint, has been making some experiments on the electro deposition of iron, a process which in Russia is used on a large scale for making paper money. According to the *Ironmonger*, the bath used is a solution of ferrous sulphate and magnesium sulphate in equivalent proportion, of specific gravity 1·155. The solution must be so far neutralised by the addition of magnesium carbonate, that blue litmus paper scarcely shows any acid reaction. A wrought iron anode about the same size as the object to receive the deposit, must be employed, and the best interval between the poles is found to be four centimeters. Mr. Roberts-Austen finds that the current best suited for an iron medallion had a strength of only 0·089 ampere. It was provided by two Smee cells, coupled up for intensity. The adherence of the iron to the copper on which it was deposited, was reduced by coating the latter with a film of metal, but Mr. Roberts-Austen is trying a thin layer of silver iodine on the copper moulds.

The deposited metal is very pure, and its magnetic capacity does not appear to be high. The dies for the Jubilee coins were made by this process of electro deposition. The designs, modelled in plaster, were reproduced in "intaglio" by the electrolytic deposit of copper, and on the copper moulds, so prepared iron was deposited. It is of hard and excellent quality, and dies of all sorts for coins have been produced by the reducing machine from such deposits.

Capabilities of Australia.—We copy the following passage from an Australian paper, in proof that there, even more than in England, the capabilities of the land are not fully appreciated :—"Among the long list of products which we might grow is coffee. That we can grow it has been conclusively proved by Mr. A. H. Leu, of Goonellabah, near Lismore, Richmond River. This gentleman has twenty acres of land on the sunny slope of a ridge, about two miles from Lismore. The soil is a volcanic loam, interspersed with large lava blocks or bluestone. In the face of this slope he has, with great labour, constructed terraces, upon which he grows numerous products, consisting of Brazil cherries, coffee plants, guavas, olives, almonds, nectarines, apricots, walnuts, mangoes, pears, peaches, citrons, figs, wild goose plums, bananas, pineapples, common apples six inches in diameter, custard apples, date plums, vines, etc. That all these fruits will grow and mature in the same garden speaks volumes for the productiveness of the soil and the evenness of the climate. Many more products could be added to this, such as tea, arrowroot, tapioca, linseed, oranges, and cotton. It is, however, with coffee we have now to deal. The plants are of the famous Mocha variety. They are still young; and there are only few of them. Great difficulty was experienced in obtaining plants or seed. The trees are as healthy-looking as plants can be, free of insect and scale pests; and they are fairly loaded with fruit."

Water Power at Schaffhausen.—The large installation of turbines and telo-dynamic transmission of energy by wire rope which has existed at Schafthausen during the last twenty years has, according to *Industries*, been so successful as a commercial undertaking, that the company owning the plant and goodwill intend to extend their operations. A few days ago they asked the town authorities of Schaffhausen for an additional concession, empowering them to supply electricity as a motive power and for lighting purposes, to private houses and factories at once, and for street lighting as soon as the present contract with the gas company has expired. The project is for five additional turbines, each of 300 effective horse-power, and the necessary electrical plant. The power for two of these turbines has been already engaged by the Kammgarn Spinnerei, Schaffhausen, where electromotors will be used for working the mill, while the power from two other turbines will be mainly used for lighting purposes in the town and neighbourhood. The fifth turbine is in reserve. It is proposed to instal the turbines a few miles above the falls of the Rhine, so that this project will in no way interfere with the natural beauty of the district. In determining the site the promoters of the scheme have thus wisely avoided the mistake made by the engineers who projected a short time ago the use of the fall itself for driving a large factory for the production of aluminium by the electric furnace, and which was opposed locally, because it would have deprived the neighbourhood of one of the greatest attractions to the tourist.

Wood Pulp Pails.—We extract the following from an account given by the *Railway Review* of the process of manufacturing these pails. The wood, preferably spruce, is first cleared of its bark and is then cut to a length of sixteen to twenty-four inches. It is then placed against the face of a rapidly revolving grindstone, the grain of the wood being parallel with the axis of the stone. The woody substance rubbed off by the stone is washed off by a shower of water, and after being screened it forms a milk-white fluid. When the water has been sufficiently removed there remains a wood pulp which is used in the manufacture of paper and indurated fibre ware. The process of making the ware from the pulp is very simple, and is similar for a great variety of objects. To make a pail, for instance, there is a machine for moulding it from the pulp, and this machine is provided with a hollow perforated form of cast iron, shaped like the inside of a pail, and covered first with perforated brass and then with fine wire cloth. This form is pushed up into a large cast iron "hat," which fits over it very tightly. Within this hat is placed a flexible rubber bag, and between this and the inner form just mentioned the pulp is admitted in a liquid state. The pulp being pumped in under pressure, the water immediately begins to drain off through the wire cloth and perforations, and the rubber bag swells until it fills the hat. The supply of pulp is then shut off, and water under high pressure is admitted within the hat and outside the rubber bag, thus squeezing much of the water from the pulp. After some eight to ten minutes the pressure is removed, the inner form is lowered, and the pulp pail is taken out. At this stage the pulp still contains nearly fifty per cent. of water, but it is sufficiently strong to be handled. The water is afterwards dried out in kilns, and then the pail is trimmed on the outside with a gang of saws. After being sand-papered inside and out the pail is then charged with a waterproofing compound which permeates thoroughly the material of which the pail is made. It is then baked in ovens at a high temperature after each dip or treatment, and the polish which the goods present is the result of the final treatment. After this the handles are riveted on, and the pail is then ready for the market. The pail is in one piece, without hoops, so that it cannot leak or fall to pieces, and it is much lighter than any other material with which such vessels can be made.

## THE SANITARY CONGRESS OF VIENNA.

The second section discussed the question referring to the medical supervision of schools, and arrived at the following conclusions :—

1. The interest of states and families required a permanent participation of competent physicians in the administration of schools.

2. The aim of this participation should be to protect both male and female pupils against the damaging influences of overwork and the bad atmosphere of schools.

3. The means which had to be availed of were, in part, certificates by competent persons, and periodic school inspections in the presence of the managers of schools, and especially during the hours of instruction.

4. Before all, an hygienic revision by the State of all public and private schools, including preparatory schools, was necessary, and the bad sanitary conditions to be at once rectified.

5. In each body of school inspectors, and in places where there is a physician, he must have a vote and a seat.

6. Hygienic inspection of schools must be intrusted to competent physicians, and it was indifferent whether they held a public office or not.

7. Starting from the above-mentioned points of view, the participation of physicians in the matter referring to schools was to be considered as an integral part of school administration in the different states.

## A WORD FOR "GERMS."

We have heard of late so many alarming things concerning the activity of germs, microbes, or micro-organisms in the propagation of disease, that many of us look upon these tiny beings as unmixed evils, and wish that they could be entirely swept away from the earth. To do so, had we the power, would be a mistake, the consequences of which would not be slow in making their appearance. We must remember that there are germs and germs. Some of them, commonly known as morbific germs, are supposed to be at least the ultimate causes of diseases, the more immediate or proximate causes being certain poisonous compounds which these morbific germs generate if they succeed in penetrating into the living animal body.

But there are other "germs" which are not concerned in the propagation of pestilence, but whose function is to effect chemical changes in dead matter.

Perhaps the best known instance of the activity of such germs is the process of fermentation by which the decoction of barley is converted into beer, and the juice of the grape into wine. But we must well note that the agents even in these two cases are not strictly identical. Beer-yeast, if added to grape-juice, certainly breaks up the sugary matter present into carbonic acid and alcohol, but the wine thus obtained is inferior. On the other hand, the so-called ellipsoid ferment, which is found naturally adhering to the skins of grapes, if added to a solution of sugar, or to a decoction of malt, produces a fermented liquor of a decidedly vinous flavour.

Here, then, we have a very simple instance how one and the same kind of matter may yield very different products, according to the kind of ferment with which it comes in contact.

But sugary solutions may yield quite other products, if we introduce into them still other ferments. One of these converts such solutions into vinegar, and is known as the acetic acid ferment. Another kind yields lactic acid—an acid met with in sour milk and in the contents of the stomach in certain kinds of indigestion. Sometimes the brewer finds to his cost that the acetic or lactic acid ferments, or both, have invaded his vats and have overcome the beer-ferment. In this case the product is an acid liquor, often utterly unsaleable. He has, therefore, to study the conditions for keeping his ferment pure, and from preventing the introduction, as far as possible, of the acid ferments.

But we shall be much mistaken if we suppose that the utility of germs is confined to brewing and to the production of wine and vinegar. If this were all, we might, perhaps, be told by a numerous body of thinkers that their activity was productive of much more harm than good to the human race. They play a great part in agriculture, or rather in certain natural operations upon which the production of the food of plants depends. We know how that if the remains of dead animals and plants are left to themselves in an enclosed atmosphere, perfectly *sterilised*, that is freed from all of these germs, they do not decay, and are in consequence never resolved into manure. But the germs of putrefaction are everywhere in nature, in the air, in the water, and in the soil, and they quickly break up lifeless organic matter into states in which it is fit to serve for the food of plants. Thus the great circulation of life in the world is kept up, the remains of past generations serving as food for their successors, present and future. To arrest this play would be to bring life, or rather the possibility of life, to an end. Certain interesting researches, in which Mr. Warington has taken a leading part, show that in the upper layers of arable and pasture lands there exists a kind of germ busily engaged in converting the nitrogen of defunct animal matter into nitric acid. This is the *rationale* of nitre-beds, in which urine, blood, etc., are converted into saltpetre, the acid combining of course with alkaline matter present in the soil. In this state the nitrogen is most readily assimilated by growing plants.

The question is farther raised whether such germs in the soil do not do a something beyond merely bringing the nitrogen present in the excretions and the remains of animals fit to be used over again. The recent researches of M. Berthelot seem to indicate, if they do not actually demonstrate, that through the instrumentality of such germs the soil is able to seize upon the free nitrogen of the atmosphere and convert it into ammonia and nitrates ready for the maintenance of plants.

Other germs seem to be engaged in the important task of purifying the waters—freeing them from organic pollution. At least Dr. Dupré has been led to this conclusion by his recent observations and experiments.

If this view is correct we are placed in a curious dilemma, as far as the purification of foul waters is concerned. Some authorities maintain that a process of filtration or precipitation, to be successful, should remove all germs from water. If not, disease-germs may be present. But if we were to thus free it entirely from all micro-organisms we should remove the useful micro-organisms along with those which are the bearers of disease. Agents or processes which would destroy the one would destroy the other also. In practice, however—perhaps fortunately—this difficulty can never arise. We cannot free water from germs; do what we please, a fresh supply will be constantly introduced by the air, the rain, and by dust.

We may find germs playing yet another part, sometimes useful and sometimes hurtful, in indigo-dyeing. Most persons know that indigo, in its ordinary commercial state is insoluble. If brought in contact with certain chemicals it is dissolved, and at the same time reduced to a pale yellow substance known as white indigo. If textile goods are immersed into it in this state and are then exposed to the air, the white indigo which adheres to the fibre is reconverted into ordinary blue indigo by the oxygen of the atmosphere. This change of blue to white indigo is effected where woollen goods are concerned by a process which is as true a process of fermentation as that conducted by the brewer, though a different ferment-germ comes here into action. But again, just as in brewing, false ferments often find their way into the vats, wasting more or less of the indigo, and occasionally destroying it altogether, thus occasioning a heavy loss. Hence great skill and much experience are required on the part of the indigo-blue dyer—though hitherto he has worked by rule of thumb—to guard against such false fermentations. It is now found possible to breed or cultivate the genuine ferment in a state of purity and to add it to the indigo in place of the empirical mixtures of grape-sugar, bran, urine, woad, madder, rhubarb-leaves, etc., which have been used to set up fermentation, and which were exceedingly likely to bring with them germs which were not wanted.

The process by which indigo is extracted from the indigo plant is also a fermentation in which various germs may take part. Hence it sometimes proves a failure. If the conditions of the process were closely studied it would doubtless be found possible to breed the proper ferment in a state of purity and give it exclusive play in the vats. We think it likely that by attention bestowed in this direction not merely the quantity but also the quality of the indigo harvest might be strikingly improved.

One concluding reflection may here be permitted; we cannot study germs without seeing the importance of little things. Almost all the great processes of nature, in as far as they depend on living beings at all, turn on the activity of beings minute, if not microscopic.

## ILLUMINATION OF WATCH DIALS BY THE ELECTRIC LIGHT.

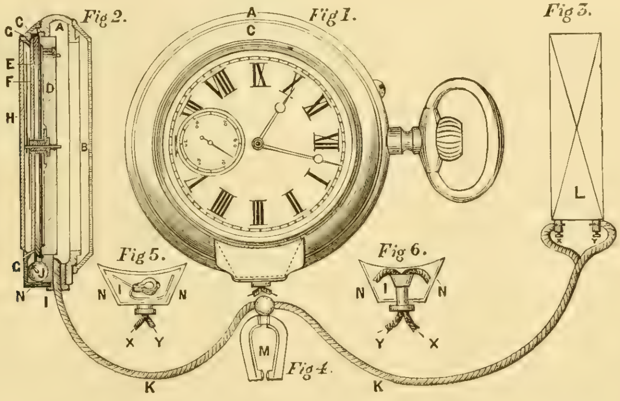
THE following description of Mr. Charles Humbert's invention is taken from the pages of the *Deutsche Uhrmacher Zeitung*:—

In the drawing, Fig. 1 represents the outward appearance of a watch of this kind.

Fig. 2 is a sectional sketch of the watch case with the lamp, and constituent parts of the illuminator.

Fig. 3 shows the generator, which may consist either of a bichromate cell or an accumulator, or any other suitable means of supply.

Fig. 4 illustrates the disposition of the intermitter, in the shape of a horseshoe, connected with the watch chain or conductor.




WATCH WITH DIAL LIGHTED ELECTRICALLY.

Fig. 5 is the upper, and Fig. 6 the lower, view of the lamp and reflector N carried by the insulator I.

In each drawing like letters represent like parts.

As in ordinary watch-cases, the middle part, A, Figs. 1 and 2, is furnished with a cover B and a bezel C. The pillar plate D is secured on the rim of the middle part A of the case. On the pillow plate D (Fig. 2) is a polished metal plate fixed by pins and screws, which has neither figures nor minute divisions. The latter are painted on a ground-glass plate F (Fig. 2), which is secured to a ring G a short distance from E. The arbors of the hour, minute, and second go through the plate, the space between E and F and the glass plate F (dial), so that the hands travel as usual between the last named and the watch glass H (Fig. 2).

The inner area of the ring G is conical and polished, and is inclined to the plate E, to equally divide the rays of light that pass through the aperture on to the plate E without being obstructed by the shadows of the arbors of the hands.

The whole of the above arrangement may be said to consist of a flat reflector, in connection with a ring-shaped reflector and a source of light for the purpose of illuminating the ground-glass dial upon which the hours and minutes are painted, over which the hands travel.

The electric lamp J is enclosed in a cavity (Fig. 2) formed in the middle of the case A and of the bezel C.

The lamp J is fastened on an insulator I (Fig. 2) furnished with a reflector N, and through two conductors X and Y (Figs. 3, 5, and 6), which form a string K connected with the battery L.

The intermitter attached to the conducting wire, or watch chain, causes the current to be closed by pressing together the arms of the horseshoe.

This arrangement seems to us particularly adapted for deck watches.

## WEIGHTS AT DIFFERENT AGES.

AN interesting and not unimportant investigation has lately been made about the amount of change that has occurred in our race during successive generations. An old-established wine-firm of the highest class in London, the Messrs. Barry, have kept, for over a century, huge beam-scales in their premises for the use and amusement of aristocratic customers. Upwards of 20,000 persons have been weighed on this balance since the middle of last century, and the results are recorded in well-indexed ledgers. The weighings were made in ordinary in-door clothing. Mr. Francis Galton, the well-known authority on heredity, has taken some trouble in selecting the records of the nobility, because the exact ages of that class can be easily ascertained. He has secured notes of age and weight of 110 peers and 29 baronets. These were born at various times between 1740 and 1830. This interval he has divided into three equal parts, and compare the averages. In the first period the average man weighed, at 25 years of age, 165 lbs.; at 30, 175 lbs.; at 40, 185 lbs.; at 50, 188 lbs.; at 60, 185 lbs.; at 70, 180 lbs. In the second period the average man weighed, at 25 years of age, 168 lbs.; at 30, 172 lbs.; at 40, 175 lbs.; at 50, 180 lbs.; at 60, 178 lbs.; at 70, 177 lbs. In the third period the average man weighed, at 25 years of age, 165 lbs.; at 30, 167 lbs.; at 40, 172 lbs.; at 50, 175 lbs.; at 60, 184 lbs.; and at 70, 190 lbs.

There can be no doubt that the dissolute life led by the upper classes about the beginning of this century, which is so graphically described by Mr. Trevelyan in his "Life of Fox" has left its mark on their weight-traces. Many a stroke of gout was there! From these numbers we find that the age at which the weight reaches its maximum is earlier in the earlier generations. This shows an improvement in later years with regard to fast living. Comparing the weights for age in the selected members of the nobility with those of the professional classes, extracted from the anthropometric tables of the British Association, we find that where, in the class of the nobility, the age is 27, the weight is 165 lbs., whereas in the professional classes it is 161 lbs. In the same way, at the age of 30, the weights are respectively 165 lbs. and 167 lbs.; at 40, 171 lbs. and 173 lbs.; at 50, 175 lbs. and 174 lbs.; at 60, 181 lbs. and 174 lbs. It is so far gratifying to notice that the weights are so gradually rising from early manhood to late years in the nobility as well as in the professional classes.

## TECHNICAL EDUCATION ABROAD.—II.

THE Hoe School, and the Auchmuty Trade Schools, both in New York, illustrate two modes of foreign technical education. They have in common as their purpose perfection in special arts. This they seek by the improvement of boys and young men in actual work. In this they have the support of the labour organisations, which allege against the system of general knowledge that, while it displaces apprenticeship, it but sets up in its place, by a short process, a half-educated mechanic. Mr. Edward Atkinson, a distinguished American economist, gives his opinion thus:—"We are training no American craftsmen, and unless we devise better methods than the old and now obsolete apprentice system much of the perfection of our almost automatic mechanism will have been achieved at the cost not only of the manual, but also of the mental development of our men. Mills and machine shops will become mental stupefactories." The Hoe School, which is that of the well-known printing-machine firm, is for the special training of the firm's working lads, who as the sons, for the most part, of their own workmen, have only had the education of the common schools. They are not apprentices, being under a mere verbal contract, with this condition, however, that they are to attend the evening school attached to the factory. The school is free, and its course of instruction has direct bearings upon the advancement of the calling which the lads have selected. To begin with, they are instructed in mechanical drawing by rule and compass, and in arithmetic, algebra, and geometry. Lectures and conversaziones follow, with the outcome, shown by the experience of five-and-twenty years, that the Hoe printing-machine reflects the average excellence of the Hoe mechanic. While attendance at the evening school is obligatory upon the lads, the conditions are not irksome. The average number of the working lads is 250, and Mr. Peter S. Hoe, speaking of the system, says:—"The firm did not look for any direct results from the school, nor did he think that, as a matter of dollars and cents, it was a paying affair. He had a conviction, however, that all labour employers should take an interest in the moral welfare of their employes, and in this particular instance the boys were so circumstanced that it was good to take them away from their associates, and to give them some guidance into better methods of life. The school had resulted in a thoroughly good understanding between the firm and the workmen. He did not believe in attempting high education for poor lads. There was no written contract, but the boys knew that it was part of their duty to attend school."

Col. Auchmuty, the founder of the Auchmuty Trade Schools, is a gentleman of position in New York. His hobby is the production of American specialists in labour, as in the professions. A brief summary of his views, and of what they have led up to, should be preceded by the statement that he regards the trade school graduation at the Imperial Technical School at Moscow, and at the Hampton Institute, Virginia, as the ideal which trade reformers in the United States should seek to establish. Col. Auchmuty's fundamental doctrine is, that the first requirement of labour is strength, which, if applied to doing some one thing well, its value is much increased. This assumption he upholds by such arguments as these. For the most part skill is a thing to be acquired, and its acquisition is by experience. Next, in the modern organisation of labour it does not pay an employer to furnish experience to lads, who as a consequence should be able to acquire it without the profit and loss considerations inseparable from engagement in the occupations. In other words as lawyers, physicians, and engineers are expected to learn their professions before they ask for employment, why not also those who seek to live by the labour of their hands? As for the apprentice system, he holds that it was only suited for the middle ages. The apprentice has been superseded by the "hired boy," who is expected to make himself useful; learning what he can by observation, and putting his hand to such practice as may be afforded him. That many employers give much time to boys is no doubt true, but equally true is it that probably as many more relegate instruction to the foreman and the journeymen. Thus, in a general way, there is little trade teaching. The foreman is interested in turning out the best work at the least cost, which generally would be impossible with boys. He therefore keeps each workman at what he does best. He is not employed to teach, and may not have any personal interest in a single lad. When old enough to do a day's work, a lad will make the best claim he can for the wages of a journeyman, such skill as he may possess having been acquired in spite of the system which is supposed to teach him.

Such may be taken as a fair expression of the convictions which led Col. Auchmuty to establish his trade schools. These form a block of four semi-detached buildings of ordinary workshops. There are departments for plastering fresco-painting, plumbing, brick-laying, stone-cutting, and carpentry. The course of practical instruction in each of these departments cannot be described without entering upon technicalties not interesting to the reader. Suffice it to say, that it is exceedingly thorough. Lectures are also given on trade subjects, at which each member of the class is furnished with a printed form, containing a list of questions on these subjects with blank spaces for the answers. The lecturer writes an answer to each question on a blackboard, and the members of the class copy it in the blanks left in the printed forms. Before proceeding to a new question the lecturer explains fully what is meant, and illustrates his meaning by diagrams on the blackboard. The forms are retained by the young men for future reference. As the instruction is intended to be thorough, the course both practical and scientific is not deviated from. The instructors cause each member of the class to begin at the beginning, and each member of a class is advanced as rapidly as proficiency will allow, but no member of a class is taken from any work until he can do it well.

CAMBRIDGE.—A grant not to exceed £150 has been made from the Worts Travelling Scholars' Fund to Mr. H. B. Smith, B.A., of Trinity College, for the purpose of archæological research in Cyprus, on condition that the objects obtained by means of this expenditure become the property of the University, and that Mr. Smith furnish a report on the results of his researches to be published.

## THE POLYGRAPH.

MANY of our readers are doubtless familiar with this ingenious instrument, which consists of a disc (shown in Fig. 1) perforated and stamped in such a manner as to combine in itself the qualities of straight and curved rules, dividers, protractors, and scale. It is useful in elementary schools for teaching correctness of eye, and for laying the foundation of accuracy in geometrical drawing, as with a little care and practice figures (such as those shown in Fig. 2) can be drawn easily and quickly by young children.

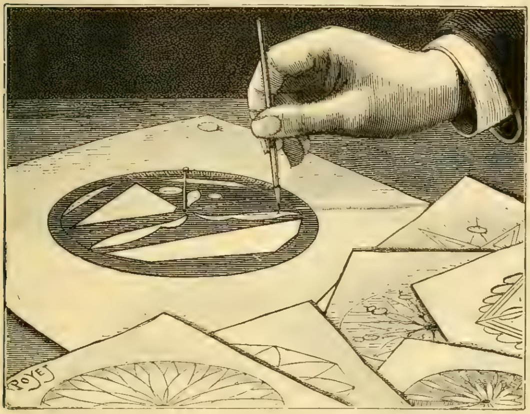


Fig. 1. The Method of Using the Polygraph.

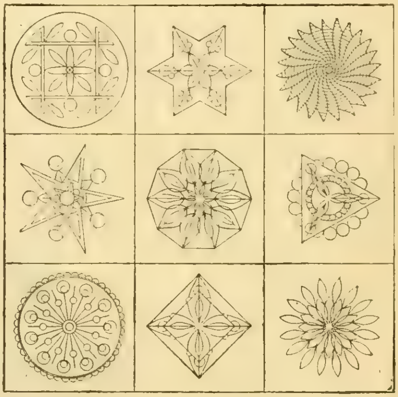


Fig. 2. Specimen of Designs Made with a Polygraph.

Luminous Organs of a Fire-Fly.—Dr. Dubois has investigated the light-emitting organs of the *cucuyo*, or *Pyrophorus noctilucus*. They are three in number—two prothoracic and one ventral. The prothoracic plates give a good illumination in front, laterally, and above, and serve when the insect walks in the dark; when it flies or swims, its fine abdominal lantern is unmasked, throwing downward an intense light with much greater range. The insect seems to be guided by its own light. If the prothoracic apparatus is quenched on one side with a little black wax, the cucuyo walks in a curve, turning toward the side of the light. If both sides are quenched, it walks hesitatingly and irregularly, feeling the ground with its antennæ, and soon stops. The light gives a rather long spectrum from the red to the first blue rays; it is more green than the light of *Lampyris noctiluca*, and has a photographic action, but does not develop chlorophyll. No distinct electric action could be traced in the organs. The luminosity does not depend upon oxygen, for it is the same in pure oxygen, in air, and at pressures under one atmosphere. The organs are still brilliant when separated from the body, but the power of emission appears to depend upon a supply of water, and it is recoverable, after thorough drying, upon putting the organs again in water. Dr. Dubois found that the photogenic substance is an albuminoid, soluble in water and coagulable by heat; it entering into contact with another substance of the diastaste group, part of the energy liberated appears as light.

## DEFINITION OF SCIENCE.

WE borrow the following definition from a contemporary:—"Science is not mere knowledge. No accumulation of facts, however important in themselves, and however accurately observed and faithfully recorded, constitutes a science. The facts must be co-ordinated and shown forth in their relations of co-existence and succession. If this has not yet been done, or if from the arbitrary and casual nature of the facts it cannot be done, the study is erudition, or learning, but not science.

"Science must also be carefully distinguished from the arts, whether fine, useful, or useless. Science sees phenomena, records them, traces their laws, and to this end questions nature, her sole object being truth. Where completely successful she attains prevision.

"Art, on the contrary, seeks to produce, to modify, or to destroy. Her sphere is action. She aims at power and enjoyment, and where completely successful she creates."

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Popular Education.—The London Society for the Extension of University Teaching has arranged to hold courses of lectures at Essex Hall, Strand. Among the subjects for the short courses of three weekly lectures is "Electricity in the Service of Man," by Mr. W. Lant Carpenter, B.A., B.Sc., M.S.T.E. The admission fee to each lecture is one penny.

Prizes for Art Workmen.—The articles in competition for the prizes offered by the Society of Arts must be delivered on or before Saturday, December 3rd.

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## COCAINE.

THE benefit of cocaine in the removal of pain from mankind has been found to be second only to chloroform. From the coca leaf has been produced an anæsthetic which can deaden any part of the human frame, so that a successful operation can be performed at that place without affecting the brain or weakening any other part. Coca, the dried leaf of the Erathroxylon coca, belongs to a class of stimulating narcotics, but it is more remarkable than either tobacco or opium in its effect upon the human frame. It is a native of the tropical valleys which occur on the eastern slope of the Andes, in Bolivia and Peru. The bush attains the height of seven feet, with oblong leaves, as shown in our illustration, taken from a drawing of a young plant grown by Mr. Thomas Christy, F.L.S., of Sydenham, and resembles the blackthorn in its small white flowers and bright green foliage. The leaves are about the size of those of the cherry tree, and when ripe enough to break on being bent are collected by women and children, and dried in the sun. One hundred plants yield about twenty-six pounds at a crop, and the total produce averages 800 lbs. of dry leaves per imperial acre. These sun-dried leaves form the coca of commerce.

The use of this plant among the Indians of South America dates from a very remote period. When the Spanish conquerors overcame the native races of the hilly country of Peru, they found extensive plantations of the herb. They observed, also, that the inhabitants were given to chewing its leaves during frequent short periods of repose. So much was the coca prized that it formed the usual money or medium of exchange in Peru. The beloved leaf is still to the Indians of the mountains the delight and support of their life. The natives there are rarely found without the leathern pouch full of coca leaves. They chew about two ounces in twenty-four hours; by this their strength is kept up, and their native melancholy dispelled. It has come to them as a relic of the ancient enjoyments of their race; and to it they attach very superstitious ideas, which triple, in their imagination, the benefit they receive from its use. When chewed in moderation, it sustains life in a marvellous degree; cases being not unfrequent of Indians who used it attaining the great age of 130 years. Clusius, writing in 1605, says that when he asked the Indians why they always had the coca in their mouths, the answer was that when using it neither hunger nor thirst annoyed them, while their vigour was most materially confirmed. Even at the present day the Indians regard the coca as something sacred and mysterious. This impression has been inherited from their religious observances, for the coca was used in all the ceremonies of war and peace. The most careful observers have ascertained that, in addition to the ordinary properties of a weak narcotic, the coca leaves possess two extraordinary qualities not known to coexist in any other substance. These are the power of lessening the desire for ordinary food, and of preventing the occurrence of that difficulty of breathing which is usually felt in ascending mountain slopes. With a feeble ration of dried maize, the Indian, if duly supplied with coca, toils under heavy burdens up the steep slopes of the mountain passes, or digs in the mines, insensible to weariness, cold, or hunger. Even Europeans by its use can climb the heights and follow the swift-footed wild animals of the Andes without experiencing any difficulty in breathing, even when two or three miles above sea level. No fewer than ten millions of the human race chew coca leaves.

YOUNG COCA PLANT.

Till very lately, however, the marvellous properties of a preparation of the plant were not known. But a drug has been produced from the coca leaves which has powerful effects. Cocaine, the alkaloid extracted from the leaves, appears to have been first isolated by Niemann in 1860, although some claim the honour for Gadeke. The yield was exceedingly small, for from one ton of leaves only seven ounces of cocaine could be produced. This made it beyond the reach of ordinary experimentalists; for in its pure form it cost about half-a-crown a grain, that is, £60 an ounce. Cocaine has a bitterish taste, and crystalises in prisms. This bitter taste is due to the presence of theine; and it is to this theine that the remarkable properties of the drug are partly to be ascribed. In many particulars, and in its physiological action upon the system, the cocaine was found to resemble atropine, the alkaloid of deadly nightshade.

Cocaine unites with acid to form salts, the best known being the hydrochlorate, though the nitrate is more used. The former preparation consists of small white needle-shaped crystals, with a peculiar characteristic odour, and is soluble in water in the proportion of one to four. When Niemann first extracted the drug from the coca leaves he was surprised to find that, on applying it to the tongue, he experienced no taste, and the tongue was destitute of feeling. Two years afterwards, in 1862, Schroff found that a dose of three-fourths of a grain given to a rabbit very materially disturbed the pulse and respiration. In 1874 Dr. Bennett showed that cocaine exerted its influence chiefly on the sensory nerves, and was a powerful anæsthetic. Four years afterwards Dr. Ott published a paper showing that it dilated the pupil of the eye just as in the case of an excess of chewing the leaves. The very high price of the drug, however, prevented for a time any continued experiments upon the lower animals, and it was not till 1884 that the beneficent effects of the wonderful pain-reliever were publicly demonstrated.

At the Oculists' Congress, held in Heidelberg three years ago, Dr. Koller, of Vienna, first publicly showed the action of cocaine when applied to the eye. He had long been aware of the anæsthetic power of the drug on the larynx; but at the Congress he publicly introduced two drops of a two per cent. solution into the eye of a patient, and in two minutes pointed out that the sensitiveness of the surface had been affected. Two drops of a four per cent. solution completed the deprivation of all feeling in the eye. A probe was pressed upon the front hard, transparent covering of the eye until the surface was indented; the lids were stretched to their utmost, and the globe was moved about in various directions by means of forceps; but the patient was like one under mesmerism, suffering neither pain nor inconvenience.

A knowledge of Dr. Koller's famous experiments and remarkable discovery spread rapidly, and in a few days hundreds of workers were in the field, keen to make improvements on its application, and anxious to have their names connected with a discovery which seemed to be about as beneficial to suffering humanity as chloroform had proved itself. Cocaine was dropped into the eye, rubbed into the skin, applied to the larynx, and even injected. An unwonted excitement possessed the medical world, eager to win Simpsonian laurels. Though many well-meaning but over-enthusiastic writers on the subject, in detailing the results of their own experiments, have exaggerated the beneficial effects of the drug on its application to the different parts of the frame, there is no doubt it is of inestimable value for the prevention of suffering in operations on the eye. Professor Knapp, of the University of New York, bravely experimented on himself and on members of his own family. He found that the pupil of the eye begins to dilate in from ten to twenty minutes with a four per cent. solution of cocaine, slowly increases in size, and attains its maximum in three-quarters of an hour, and then gradually diminishes. The feeling is deadened for three minutes; sensibility then begins to appear, until in half an hour sensitiveness is restored. An experienced oculist, Dr. Argyle Robertson, of Edinburgh, has been very successful in the use of cocaine. When operating for cataract he deadens the nerves of the eye by repeated applications of a weak solution for half an hour before the operation, and the patient, though aware of a slight pricking when the instruments are inserted to steady the eye, is astonished to be assured that what was considered the preliminaries was really the operation.

Cocaine has now been shown to be a powerful anæsthetic. By it, wens, or skin tumours, are successfully removed without pain. Operations on the larynx and the ear have been painlessly performed. In certain forms of neuralgia, a ten per cent. solution in oil of cloves rubbed into the affected part affords almost immediate relief. Taken internally, small doses stimulate nerve centres, lessen fatigue, diminish the saliva and perspiration, and quicken the rate of the pulse; but large doses paralyse the nerves, produce fulness of the head, deafness, and stupidity, raise the temperature of the body and lower the pulse. The best physicians consider cocaine far before ether or morphia for local anæsthesia. It has been found very beneficial in cases of hay fever, tabloids of cocaine being successful in stopping the annoying accompaniment of this disease when all else failed. For ordinary relaxed throats, occasioned by exposure to the extreme frosts of a hard winter, cocaine lozenges have been found more advantageous than the old krameria lozenges. Of course, by rash employment in inexperienced hands, it has acted like a poison on the system of the patient, which has made the pessimists of the profession sneer down its beneficial effects; but caution as to the quantity used for the age and constitution of the patient will prevent any serious results. And, though still in its infancy, cocaine has been found by the best medical practitioners, even in country districts, to be the most important discovery since that of chloroform for the alleviation of suffering.

## CLINICAL THERMOMETERS.

The accompanying illustrations refer to a clinical thermometer made by M. Leon Bloch, of Paris. Its outward shape is very similar to the ordinary clinical thermometers, and has the usual narrow passage immediately above the mercurial reservoir (as shown in Fig. 1). This permits the mercury to pass when it is expanding, but causes the column to break when the mercury contracts, and thus records the maximum temperature attained. The mercurial reservoir in the thermometers usually employed is made of very thin glass, and expands a little with an in-

Perspective View of Thermometer.

crease of temperature. There is therefore a tendency to check the rise of the mercurial column, so that a lower temperature than that actually existing will be indicated. Besides this, some minutes must elapse before the maximum

Sectional View of Bulb.

can be taken, owing to the comparatively large quantity of mercury to be affected. In M. Bloch's thermometer, however, the bulb is made longer than usual and is provided with a second internal tube (as shown in section in Fig. 2). An annular reservoir is thus formed, and the thin layer of mercury it encloses is very susceptible to the changes of temperature of its surroundings. Moreover, the errors due to the expansion of the glass are reduced practically to zero, as the two glass cylinders expand in the same direction. The principle here introduced appears to us a sound one, and might be applied with advantage to thermometers other than clinical, as, for instance, those used for delicate experiments in thermo-chemistry. A reading microscope can be attached to the stem of the thermometer (as shown in Fig. 1), and as the graduations in these thermometers are very fine, this is a very convenient addition, especially as the microscope, when not used, can be fitted on to the end of the thermometer.

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## THE TELEPHONE: ITS PRINCIPLES, CONSTRUCTION, & APPLICATION.—V.

But the most important use of the telephone is in connection with the exchange system. The object of this, as most people know, is to enable any subscriber to an exchange to communicate with any other subscriber. The commercial and social advantages of such a system are evident, and it is found that although it is a little difficult to get people to pay for them when starting an exchange, a few months' experience teaches the most sceptical that the service is well worth its price. The arrangements just described are widely used for communication between different establishments belonging to the same firm, between the business and the residential premises of professional and commercial men, and in other similar circumstances, but there are few cases in which two firms have sufficient business with each other to justify the expense of a special communication, and it is obviously impracticable for every large firm in London or Manchester to have a special wire to all the firms with whom it has dealings. The Exchange system gives to each subscriber the power of communication with any other subscriber at the cost of only one line and set of instruments. The arrangements are simple in principle, but become intricate in practice. Each subscriber is provided with a set of instruments, such as has just been described, consisting of a transmitter, a receiver, a bell, and a ringing-key and battery, or magnet machine, connected with a line wire running to the exchange. At the exchange each line wire is connected to a switchboard, which is under the observation of an operator. As a rule, each switchboard takes fifty to one hundred lines, so that in a large exchange there will be several boards, and as many operators on duty. Each wire has allotted to it an indicator and a simple means of making a connection to it by pushing a plug or jack into a hole or slot on the board. The operator is also furnished with a set of speaking and ringing apparatus, which she (telephone operators are mostly girls) can put into connection with any line at will, and also with a number of flexible wire-conductors, each furnished with a plug or jack at each end, to enable her to connect any two lines together. The indicator and the connecting-hole allotted to each line are marked with the subscriber's number in the telephone list. When a line is not in use, it passes through the indicator and to earth, through a spring which presses against another one connected to the earth. These two springs are opposite to the hole or slot in the board, and when a plug or jack is inserted they are separated and insulated from each other. The indicator consists of an electro-magnet, which, when excited by a current passing through it, allows a little shutter to fall and reveal the subscriber's number in bold figures. Sometimes the fall of the shutter is made to ring an electric bell, but this is not necessary with attentive operators, and is rather a source of distraction and annoyance in a busy exchange. The following is the routine of connecting two subscribers together. Suppose that number 212 wishes to speak to number 250; 212 works his ringing apparatus, and the operator signifies her attention by ringing his bell. 212 then takes his receiver off the hook, and says, "Connect me to 2 5 0." The operator repeats the figures back, and 212 then hangs up his receiver. In a minute or two his bell rings again, and taking down his receiver, he finds himself in communication with 250. On the completion of their conversation, both hang up their receivers, and work their ringing-key or magneto. The operator, on perceiving that indicator shutter 212 has fallen, puts a plug into No. 212 hole, which plug disconnects line 212 from earth, and connects it to her speaking and ringing apparatus. She then rings back to 212, and immediately afterwards lifts her receiver to her ear; or, if it is carried on an ear-high stand (as is usual to save time and fatigue), switches her speaking apparatus into the circuit, and hears 212 ask for connection to 250. She repeats back the number asked for, and if 250 line is not in use, which she can see at a glance, connects her apparatus to 250, rings him up, and as soon as she gains his attention, connects the two lines together by means of one of the flexible cords, first giving 212 a ring up to notify him that he is connected. When the conversation is completed, the ringing current makes an indicator shutter in circuit with the flexible connection-drop, and the operator withdraws the plugs and leaves the two lines free. In practice, a number of switches are in use, which enable the operator to readily connect either her ringing or speaking apparatus to each line which is calling or being called, or to interpolate her apparatus between two lines which are in use, and break in upon the conversation with a hasty "Have you finished? Have you finished?" which is sometimes very provoking. The illustration suppose that both lines are on one board and under the control of one operator, but in large exchanges there are a number of boards. The different boards are connected together by short lines, each with its indicator and connecting-hole, and if a subscriber connected to one board wants a subscriber connected to another, the operator controlling the board on which the call is received has to ask the operator at the board to which the required line is connected to connect that line to one of the lines between the two boards; and the first operator then proceeds exactly as if that line to the other board were the line she requires, as of course it practically is. In London and some other large towns, distance, the number of subscribers, and the difficulties in the way of bringing a very large number of wires to one centre, render it necessary to have a number of exchanges scattered over the town or district. These are connected together by "trunk lines," and every operator knows at once, on being asked for a connection to a given number, what exchange it is on, a certain range of numbers being allotted to each exchange. When any subscriber on one exchange wishes to communicate with a subscriber on another, the operator has to get the required line "put through" to her, in much the same way as if it were merely on another board in the same exchange. It will be easily seen that when several hundred lines have to be provided for, the number of cross-connections becomes very large. As simplicity of working is the great object aimed at, in order to economise time and prevent misconnections as far as possible, and as simplicity of working involves complication in the apparatus, the necessary connections become very intricate indeed. In a telephone exchange of the first order, the number of separate connections amounts to hundreds of thousands, and many miles of insulated wire are employed in making them.

The description given is a general one, as there are many systems in use, mainly differing in the pattern of the apparatus employed. One system in use in the United States enables every operator in an exchange, however large, to see whether the line she wants is engaged or not, and to connect the calling-line to it directly, without communicating with any other operator. The connections and amount of apparatus involved in such a system can, however, hardly compensate for the increased simplicity of working. A large exchange fitted up in this way must be the most complicated system of electrical connections in existence, and one feels inclined to pity the man responsible for repairs and additions to it.

The number of subscribers connected to each switchboard should be such as to just engross the attention of the operator. This number varies with the size of the exchange, other things being equal, as the number of calls per wire increases, in about the same proportion as the number of subscribers on the exchange; or, in other words, and speaking roughly, the total number of calls in a given time is proportional to the square of the number of subscribers connected to it.

As has already been hinted, the telephone has been utilised for a number of scientific researches. The sensitiveness ot the Bell receiver to alternating or intermittent currents has enabled electricians to use it in investigating many phenomena which are otherwise not easily brought under our ken. Professor Hughes has taken the lead in these applications, and has been enabled to demonstrate several new and interesting facts in magnetic and electrical science. Incidentally, by means of his induction balance, he has given the scientific world a means of discovering exceedingly slight differences in the composition, form, or weight of two pieces of metal—*e.g.*, two coins, which should be identical; and by another application of the same instrument, which has a Bell telephone for its indicator, has shown surgeons how to localise a bullet or other foreign metallic substance in the human body without probing for it. He has also shown why an iron wire is far less efficient as a conductor for a telephone or a rapidly-working telegraph line than a copper wire. The fact had been observed before, but the reasons were not clearly known. The Postal Telegraph Department has not been slow to utilise the fact, and has already erected many hundreds of miles of copper wire for rapid telegraphy, with the result that the highest speed that could be obtained between London and Newcastle on an iron wire was increased 12½ per cent., or from 368 to 414 words per minute, by the simple substitution of a copper line wire.

As the copper is lighter than the iron, and need not cost more, this is a very useful practical result. The Telegraph Department found it out experimentally by erecting nearly 300 miles of wire. Professor Hughes, with the help of his clever utilisation of the sensitive Bell telephone, showed the same fact as clearly with ten inches of each kind of wire.

To mention and briefly explain all the scientific uses of the telephone would lead us to nearly every branch of physical science, and swell this article to far beyond any permissible length.

The commercial uses are being rapidly extended by "trunk lines," connecting the telephone exchanges of neighbouring towns. For example, London subscribers can speak to Brighton subscribers, and Glasgow to Edinburgh, whilst most of the manufacturing districts of the north and midland counties have their various towns connected together; and soon it will be possible for a Liverpool subscriber to speak to a subscriber on any exchange in the South Yorkshire district, as well as any in Lancashire, Cheshire, and Derbyshire.

This subject leads into the question of long-distance telephony, which requires separate treatment, and involves a good many rather abstruse technical points. Long-distance telephony is, however, an accomplished fact, and Brussels and Paris are now regularly connected with a telephone wire.

As great a distance as 1,000 miles is said to have been spoken over in the United States; and, given a suitably built and environed line, there is no reason to doubt the assertion.

For military telegraphic purposes the telephone promises to be extremely valuable. Used as a speaking instrument, no specially-trained staff is required to work it; but its use as a "Morse sounder" is likely to be of even more practical value, as its extreme sensitiveness enables it to be used on badly-insulated and connected lines that no ordinary telegraph instrument can work through. This same sensitiveness enables the battery power to be reduced to a minimum; batteries being heavy and troublesome, this is an important point.

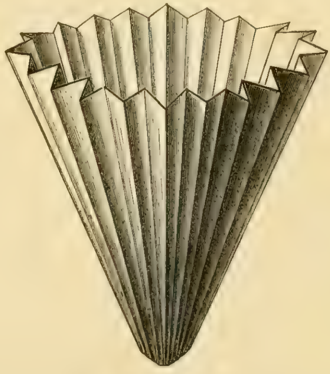
In Germany and some other states, the telephone is used by the telegraph departments for the service of the smaller offices, and no skill being required to use it, a considerable saving in operation and maintenance is effected.

The subject of this series is a very large one, both from the scientific and practical point of view, and it has hardly touched on many important and interesting points. It is necessarily imperfect in many respects, but it is hoped that enough has been said to give an insight into the *modus operandi* of this most important and useful invention, and to interest some readers in the subject and in the far wider subject of electricity and its applications.

In conclusion, the acknowledgments of the writer must be given to Professor Silvanus Thomson for information derived from his most interesting book on Reiss' connection with the telephone, and his courtesy and that of Messrs. Spon in allowing some of the blocks of that work to be used for illustrating these articles; similar acknowledgments are due to other publishers for favours of the same nature

## FOLDED FILTERS.

By the usual method of folding a filter paper, a small proportion only of the paper is effective, so chemists and others engaged in work where rapid filtration is necessary, have been in the habit of folding their filter paper,



somewhat in the manner shown in the accompanying illustration. Messrs. Schleicher and Schüll, of Düren, in Germany, recognising the loss of time thus occasioned, are now selling filter paper folded ready for use in various sizes, and we strongly recommend their use

Abridgment of Address by Sir James Paget, Bart., F.R.S., Delivered at the Owen's College, Manchester, at the Opening of the Medical Session, 1887-88.

I WISH to speak on the utility of scientific work in the practice of medicine and surgery; not in the sense of using, for the purposes of practice, all the medical scientific knowledge that has been acquired, but in that of using, after a scientific manner, all the opportunities which practice affords for the acquirement ot more knowledge. In our calling careful practice and scientific study should be inseparable; they always may be so; and I want to urge that every one of you should be, to the full measure of his ability, a scientific student both now and all his life long. I have seen enough to make me sure, that they who, whether they know it or not, do their work after a scientific manner are the best practitioners, and contribute most to the general increase of knowledge. Although, therefore, as I have said, my chief object may be to urge the use of science for gaining fresh knowledge by the study of what may be observed in practice, yet I would have it always understood that whoever will thus work will be all the more useful to his patients, whatever kind of practice he may be engaged in.

I shall not attempt to define "science" or "scientific." Like many of the most useful words in our language, they do not admit of any exact brief definition. What I mean by them may appear as I go on. Many of you are beginning, others have lately passed through, what are especially called your scientific studies, or the scientific part of your curriculum. I could wish that they were not so called, for it seems to imply that the studies following them are not scientific; and to some minds it implies that the studies which are called scientific are not useful—both of which are serious errors. For, to any of you who so choose, clinical study, whether in your pupilage or in your practice, whether in hospitals or in private, may be made as scientific, in any fair meaning of the word, as either chemistry or physiology; and to those of you who so choose, the studies of the first two years of the curriculum may be made very useful in after life.

Now, the first, and certainly in student life the only, safe means for becoming scientific in our profession is the training of the mind in the power and habit of accurately observing facts. Medicine and surgery are eminently a science of observation; deductions from facts are always unsafe; I believe that they have done far more harm than good; and, for the most part, when sufficient facts have been collected and arranged, the general conclusions that may justly be drawn from them are nearly manifest. The main thing for progress and for self-employment is accurate observation. Some seem to think it easy to observe accurately—they cannot doubt, as they say, the evidence of their senses. There are few greater fallacies. In scientific studies the evidence of the senses needs as much cross-examination as any evidence given in a criminal trial. Self cross-examination it may be, but it must be steady and severe. For by accurate observation we must mean not the mere exercise of the senses, not the mere seeing or hearing or touching of a thing, with some levity of thinking about it—we must not mean even the keenest use of the eye cultivated in microscopic work, or of the ear hearing sounds that to the uneducated sense would be inaudible, or the use of the finger with the most refined detective touch. All these higher powers of the senses you must acquire by careful study and practice, and you must learn to exercise them with all the attention with which a strong will can direct and watch them; but even all this, difficult as it is, is only a part ot scientific observation. This must include, besides, an habitual constant watchfulness—the taking notice of all the conditions in which objects or events are found—their concurrence, their sequences, their seeming mutual relations, all their variations. To do this, and to do it again and again, and with constant care, whether it be in things occurring naturally or in experiments—to do this accurately and always is really very difficult. A few seem to have the power naturally—there are some born naturalists, some born physicists; you have had some here—but in nearly all men, and, you may safely believe, in yourselves, the power to observe accurately needs careful self-training, self-suspicion, and self-discipline.

If accurate observation were easy, how could we explain the oversights and the errors of which the evidences abound in the whole history of medicine, and which, I think, every one could find in a retrospect of his own work? Look at the history of discoveries. As a general rule, every discovery of things that can be observed tells ot previous oversight or want of observation. Some discoveries, indeed, have followed quickly on the invention of improved means of observation, or on the advancement ot knowledge clearing away some previous obscurities. These, it may fairly be said, could not have been made much sooner; but of far more it may certainly be said that the discoveries in each generation are evidences of the oversights, the defective or erroneous observations, of men of previous times—even of the best ot them. Take some leading instances. All the facts which enabled Jenner to discover vaccination were within the range of his predecessors; they saw and heard of them, but they did not observe them; they all overlooked them, except the one farmer who vaccinated his children, but could not persuade others to follow his example. All the sounds on which Laennec established his system of auscultation were within the hearing of previous generations and of his elder contemporaries; many had heard them, but they did not listen as he did, and they did not observe the conditions in which the different sounds occurred—how each coincided with some diseased process or change of structure in the heart or lungs. All the facts by which Hunter was guided to his operation for aneurysm might have been obvious to other surgeons of his own and lately previous times. They did see them; they did not carefully observe them. I need not multiply examples. Look at any discovery of this or last year, and think whether it might not have been made in the previous year or some years ago; and when you find that it might have been and was not, though men of excellent ability were within reach of it, then you may feel that accurate and complete observation is a really difficult thing, and that for the fulfilment of your duty, whether to science or to your patients, you must cultivate the power of searching and observing with all your might.

Not a year passes but someone describes a disease of which we had no previous record—a novelty. And the first case is thought unique, strange, and, by some, not much worth thinking of; but soon similar cases are found here and there, and the new disease seems hardly rare. I will not say that no new diseases ever appear. I have long maintained that they do; but they do not come among us on a sudden, and we may be certain, whenever a case of a new disease is observed, it is not the first that has occurred or the only one existing; similar cases have been overlooked—they have been within sight and have not been observed. And without doubt there are similar examples of oversight among us still.

I wish that the arguments for this were only in the oversights, the mere defects of observation. Unhappily the errors illustrated in all the history of medicine, and in much that is still in progress, are very numerous too.

Facts, when not quite overlooked, are too often seen and recorded erroneously. I would not speak of such errors without a confession of having contributed to them, or without the fair motive of wishing to urge the best means for avoiding the like of them. For remember that many of them were made, or are being made, by men as honest as we are or ought to be, and as fairly in the pursuit of knowledge.

It would need some volumes to relate all the sources of error in scientific observation. I will mention only one, for I think it is the most frequent, and I should like you to be always watching against it. It is the habit that we have of inserting something of our own, something of our beliefs, of our expectations, nay, even of our wishes, into that which we think or say that we observe. We expect facts or events to agree with what we believe that we know, and we make light of the differences and exaggerate the likenesses; we take no thought of what we call accidental exceptions; we think them unmeaning—as if anything in nature could be without meaning—and we do not half observe them. In philosophy we can separate things from thoughts—the object from the subject; but in ourselves and in ordinary life they are mingled in every act of consciousness and reflection; and sometimes it is only by careful self-analysis and by habit studiously gained that we can separate them and observe simply and accurately.

There is a very common proverb that "seeing is believing," and many, as if trusting it, say, "I must believe what I see." It is often unwise to do so; for the sight, without the aid or control of other senses, is often fallacious. But there are many in every walk of life who, when they say "I believe what I see," might just as fairly say, "I see what I believe"; and these, though they are usually in the wrong, are usually the most positive in their assertions. They believe what they wish, and then they see what they believe; and then they become unable either to see or to believe anything contrary to their wishes—anything contrary to what they call their clear convictions. Well, as a man may see an unexpected likeness of himself in a caricature, so may we all see a defect of our own exaggerated in people such as these. We are all apt to see what we expect to see—to think that the knowledge already gained is so sure that that which is next to come must exactly agree with it. Our safeguard must be in careful scientific study—in the habit of observing without prejudice and with self-distrust, always remembering that everything brought within the range of human knowledge is brought within the much wider range of human error.

And here let me add that, however much the mechanism and other external helps for observation have of late been improved, our mental powers have not increased in the same degree; we are in ourselves as likely to observe erroneously as were our predecessors; in this sense we are not wiser than our fathers. It may even be doubted whether the improvements in the means of observing be more than in proportion to the much larger field and the more minute facts within reach of which we have been brought. It is comparatively easy now to see and do many things which used to be difficult or impossible; but it is not, therefore, easier to see and do new things. The higher we rise on the hill of knowledge the steeper and the more difficult does the ascent become. And we are not yet near the summit; it reaches up to heaven.

I might speak of many means of helping ourselves in the cultivation of the power of accurately observing, such as reading—which is, perhaps, of all the most important—and of drawing, collecting specimens, and many more; but I will speak of only one, which is far too often neglected. You will find it, I think, essential to scientific accuracy that you should have the habit of recording very carefully your observations and all the chief facts connected with them. No one should wholly trust his memory in such things; it may lose the facts, or, worse still, may gradually alter them; for, as belief and expectation and other mental states can affect the impressions which we derive from things even when they are present before us, so and much more can they affect those which we try to reproduce in memory. The self is here alone in all its fallibility.

I have heard a very truth-loving person say that if he had ever told the same story ten times he always became doubtful whether he was telling it rightly. You may do well to remember this when you are telling cases. You know the game in which a story is handed on through ten or more persons, and then there appears very little likeness between that told by the first and that told by the tenth. None of them have wilfully changed the facts, but every one has been a little inaccurate, and the inaccuracies have accumulated. There is some measure of the same difficulty of exact representation of facts by each person's own memory, and we cannot too carefully guard against it. Inaccuracy, it has often been said, has done more harm than falsehood has; and this is certainly true in our own sciences.

Now there can be no better safeguard against these mischiefs than the habit of making studious and careful records of the things that you observe. It should be a constant habit of student life; and, let me earnestly add, these records should be made whenever and as completely as they can be while you have before you that which you are to describe, so that you may write down the very few facts that you are observing, and may revise them whenever you have a chance in the presence of the same or similar facts.

I hope I shall not make your future studies seem utterly hateful to you by thus speaking of them as if they were only full of pitfalls and occasions of mischievous error. Really there are none that you may not avoid; but you cannot be too cautious; so I shall continue my advice, for most of us need to be still more careful when in our studies we pass, as we always do, from observing to thinking, and to what we believe to be reasoning. John Hunter, it is reported, used to say to those who would draw conclusions rather than search for facts, "Don't think; try." Happily for science, he often did not observe the rule; he was one of the very few who could really sometimes think a truth far beyond that which could be observed; but we are not all like him, and for all of us the saying is an excellent one, "Don't think; try." Do not suppose that you can safely think what must follow from what you know; try whether it is so. Do not think that you can safely explain what you observe by any hypothesis or theory; and that having thus explained it, there is no need of studying it further. Collect new facts and "try" your theory by them, and if the theory and the facts do not agree, stick to the facts; they will accumulate into larger truths. We must have theories, or explanations as they are called, of many of the facts which we observe. We need them to help us to the best ways available for arranging the facts, as we need bookshelves for books; and they are useful for suggestions as to what, and where, and how to search for new facts. But here, or hereabout, should be the limits of their use; and the using of theories for purposes beyond these is full of danger, and often a great hindrance to progress.

As one looks back on the relations between the collection of facts in practice and the explaining of them in accordance with the theories which were in successive times accepted, and which were commonly called "general principles," and regarded as safe guides in the treatment of disease, we may fairly doubt whether the gain or the loss were the greater You will see that in each successive generation every fact observed in practice was accepted, not merely as a fact, but rather as an illustration of some pathological doctrine of the time. Mercury was, at different times, an antiphlogistic, a depurative, an alternative, and I know not what besides—harmless words if they had not been used as facts; but because it was thought, not known, to be all these and more, it was so misused and did so much harm that it nearly lost all its just repute, and many disused it. Similarly, bleeding was practised in excess, not so much because of the good it sometimes did, as because the physiology of the time seemed to prove that it must be useful in a large number of conditions in which it was not. And because this was deemed sure, men overlooked the evidence that it was often useless and sometimes mischievous; they did not observe; they preferred thinking, and they thought erroneously, and were guided by their thoughts more than by the facts. Now, these were errors of men as honest and as clear-headed as any in our own day, and among them were some to whom medicine owes great help to progress. Surely it should make us very cautious. I have cited old historic errors, but exactly similar modes of thinking are everywhere prevalent, exactly similar fallacies in letting doctrines rather than facts serve as our guides in practice. And we need the more caution because this assumed power of explanation is so much more attractive than the gathering of facts. The explanations are so much more our own; like very parts of ourselves; so much more impressive; they sound so learned, patients admire them—some, I have often thought, would rather have their maladies explained than have them cured.

Only learn to study after the right manner, and, as all who have had experience in it will tell you, you will find it a source of very rare happiness and utility, and of no harm whatever. There are some, indeed, who would tell you that the scientific man is ill-fitted for anything but science; that he cannot be punctual, business-like, a plain speaker, pious, or I know not what else. It would be difficult to find greater nonsense in any of the books or journals on a modern book-stall. There is nothing that a man may not be at the same time that he is scientific. I would not make light of anything that would hinder you from being business-like; for I should have to admit that I have known more failures in our profession through want of this quality than from the want of any other: more than from the utterest want of scientific or even of good practical knowledge. But the failures were not only among the scientific. Surely I need not say in Manchester that good men of science may be also good men of business; and what may be seen here may be seen everywhere. If a man of science cannot be business-like, it is the fault of his brain not of his study; he would have been the same in any other pursuit in life.

## THE INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on the 15th November Sir F. A. Abel, in a Paper on "Accidents in Mines," Part II., resumed a consideration of the views which have been entertained and challenged regarding the influence of variations in atmospheric pressure upon the liability to a sudden contamination, to a dangerous extent, of the air in a coal mine by firedamp. The careful examination of existing observations and speculations led the late Royal Commission to conclude that, while certain coincidences of fall and rise of barometer with explosions might be selected to support particular views or theories, no general connection had been satisfactorily established between colliery explosions and sudden barometric changes; and that the official issue to colliery districts of warnings of approaching changes in atmospheric conditions were to be deprecated, as tending to encourage a false sense of security, and to divert attention from other sources of danger which might be more potent. Attention was directed to the accumulation of gas, or explosive gas and air-mixture, in the goaves or old working-places, imperfectly filled up with *débris*, and often inaccessible to anything approaching efficient ventilation, of which extensive areas existed in many mines. The possibility of a communication being established between the gas-laden spaces in such goaves and those parts of adjacent coal-seams or stone strata in which blasting was being carried on, by fissures resulting from settlement of roof or other causes, was pointed out, and it was indicated that even the flame from a "blown-out" shot might, in particular classes of workings, and where inflammable dust existed in abundance, extend to goaves where an explosive mixture of firedamp and air might lurk. The importance of filling up, as completely as possible, the worked-out places or goaves in localities underground where there was any possibility of firedamp accumulations being produced, and where they could not be effectually dealt with by the existing ventilating appliances, was therefore insisted upon.

The influence of coal-dust in extending and aggravating the effects of firedamp explosions, which was first demonstrated by Faraday and Lyell, was next discussed. The fact that, even in the complete absence of firedamp in the air, a sufficient coal-dust deposit in the immediate vicinity of a working, or the employment of coal-dust as tamping, gave rise to a considerable elongation of the flame projected by a "blown-out" powder-shot, had been abundantly demonstrated by many experimenters, and a series of experiments with various descriptions of coal-dust, made upon a scale representing actual practice by the Firedamp Commission of the Prussian Government, had fully confirmed the conclusions previously arrived at regarding the important part played by coal-dust in mine explosions. This was now so thoroughly recognised that precautionary measures, bearing specifically upon the dangers which might arise in carrying on blasting operations in dusty mine-workings, constituted an important feature in the Mines Regulation Act passed last Session. The manner in which the dangers arising from the presence of dry, very fine and inflammable dust in mine-ways and workings were increased by the presence in the air of a proportion of firedamp, so small as to escape detection by the most skilful inspector by searching with a safety-lamp, was described, and the possibility of disastrous explosions resulting from the ignition by a powder-shot of highly inflammable, dry, and exceedingly fine descriptions of dust, even in the complete absence of firedamp was indicated. The necessity for removing dust from the workings, supplemented by copious watering, immediately before the firing of a shot, and other precautions, was therefore insisted upon, if powder was to be allowed as the blasting agent in dry and dusty places. The merits of other explosive agents which had been proposed as substitutes for powder were discussed, as also the origin and development of methods extensively tried by the late Royal Commission and others for applying water, in conjunction with the explosive, as a means of extinguishing flame and sparks produced in firing shots. It was shown that, while none of these could be relied upon as a safeguard when powder, or any explosive analogous to powder was employed, the water cartridge (*i.e.*, a charge of explosive surrounded on all sides by water), as originally devised and made public by the author, and the comparatively simple and even more efficient method of using water in conjunction with a porous body, such as sponge or moss, allowed of the perfectly safe employment of nitro-glycerine preparations, such as dynamite and gelatine-dynamite, and of some other "high explosives" in dusty workings; this was so, even where firedamp was present in small proportion, or where there was a possibility of the emission of gas in considerable proportion. Proposals to employ substances as tamping, or in admixture with the charge, which would evolve vapour of water, or non-combustible gases, when exposed to heat, were viewed unfavourably, inasmuch as the almost instantaneous duration of exposure to heat of such materials, when the shot was fired, would be insufficient to accomplish the desired generation of non-combustible vapours or gases to an extent calculated to exert any important extinguishing effect. The practical experience gained in the employment of compressed lime and water, according to the plan devised by Messrs. Smith and Moore, had demonstrated that this method of getting coal, which was absolutely safe in its nature, admitted of decidedly advantageous application in some varieties of coal, though it could by no means be generally substituted for explosive agents. Improvements, in point of safety, in methods of firing shots were pointed out, and stress was laid upon the advantages which would in many localities be secured by the application of electricity to the firing of shots.

The author devoted much attention to the subject of safety-lamps, and much stress was laid upon the unsafe nature of the Davy, Clanny, and Stephenson lamps, in their original forms, under the present conditions in regard to the air-currents met with in mines. It was pointed out that simple modifications of these, applicable to existing lamps, rendered them comparatively very safe, so that the exclusion of the ordinary or "unprotected" forms of those lamps by the Act recently passed need not have entailed any serious hardship or inconvenience.

An account was given of the great progress which had been made, within the last two years, towards providing the miner with a thoroughly portable, self-contained electric-lamp, capable of furnishing a light equal to that of the best safety lamps, during the entire period of a working-shift. The results obtained with secondary-battery lamps devised by Mr. Swan and Mr. Pitkin, and with the primary-battery lamps of Schanschieff, Coad, Blumberg, and others, were described. The cost of these appeared at present the most serious obstacle to the extensive use of electric-lamps by the miner. Electric-light installations, for illuminating the pit bottom, the main haulage roads to some distance, and the screens, sidings, offices, etc., on the surface, had already been adopted at some extensive collieries with beneficial results, and a very important future was opening up for the applications of electric-lighting in connection with coal mines.

## THE GEOLOGICAL SOCIETY.

At a meeting held on November 9, Prof. J. W. Judd, F.R.S., President, in the chair, the following communications were read:—

1. "Note on the so-called 'Soapstone' of Fiji." By Henry B. Brady, F.R.S.

The Suva deposit, which has a composition very similar to that of the volcanic muds at present forming around oceanic islands in the Pacific, is friable and easily disintegrated. The colour ranges from nearly white to dark grey, the mass being usually speckled with minerals of a darker hue.

The common grey friable rock yields a residue consisting mainly of Foraminifera with a few Ostracoda. Of three specimens examined, 1 is a light-grey rock from close to the sea-level; 2, of a lighter colour, from about 100 feet elevation; 3 is nearly white and somewhat harder, and was derived from an intermediate point.

Notes are given on the rarer and more interesting species, together with a list of the 92 species of Foraminifera found. Of these, 87 are forms still living in the neighbourhood of the Pacific islands. Two of the remaining 5 are new to science, and the rest extremely rare. The author concluded that these deposits are of Post-Tertiary age, formed at depths of from 150 to 200 fathoms in the neighbourhood of a volcanic region. The following new or little-known species were selected for illustration:—*Ellipsoidina ellipsoides*, var. *oblonga*, Seguenza; *Haplophragmium rugosum*, D'Orb.; *Ehrenbergina bicornis*, nov.; *Sphæroidina ornata*, nov.

2. "On some Results of Pressure and of Intrusive Granite in Stratified Palæozoic Rocks near Morlaix, in Brittany." By Prof. T. G. Bonney.

The author briefly described the banded Palæozoic slates in the neighbourhood of Morlaix, and gave a general account of their microscopic structure. They are greatly contorted and folded, and have evidently undergone very severe pressure. The result of this has been the development of minute scales of a light-coloured mica, especially in the darker bands and certain corresponding changes in the more quartzose layers. In certain places these banded slates, after they have attained the aforesaid condition, have been affected by intrusive granites. The result has been the intensification of the changes which were already incipient. The quartz granules have been doubled in size, the flakes of mica have become four or five times as large, the black material of the argillaceous bands has been gathered into large granules, and seemingly reduced in quantity (probably by partial oxidation of the carbon), and in some cases andalusite crystals or grains of considerable size have been developed. The rock has become comparatively hard, instead of friable, and the cleavage-planes are "soldered up" by the development of mica along them.

3. "On the Position of the Obermittweida Conglomerate." By Prof. T. McK. Hughes.

The author gave an account of a visit to the section at Obermittweida, fifty miles S.W. of Dresden, where there is an apparent intercalation of conglomerate and sandstone in a gneissic series. West of the stream at Obermittweida there is seen a crushed but not much altered conglomerate of felsite and other pebbles, above which gneiss and mica-schist rest, apparently in true sequence numerically. Below the conglomerate no rocks were seen, but at a little distance to the eastward coarse flaked muscovite-schists and gneissic rocks were exposed, apparently underlying it. By a diagram the author showed how the conglomerate might belong to much newer beds caught in a synclinal fold of the schists, and he advanced various arguments in support of this explanation.

4. "On the Obermittweida Conglomerate: its Composition and Alteration." By Prof. T. G. Bonney.

The author was indebted to Professor Hughes for the opportunity of examining a fine series of specimens of this rock, collected by the latter.

The materials appear to have undergone a certain amount of metamorphism, and the author is of opinion that the materials are rather more altered than is usual in Palæozoic greywackes and conglomerates, but that the comparatively small amount of alteration, and the character of the included fragments, render it highly improbable that the conglomerate is in stratigraphical sequence with the above-described gneiss, or with any similar series of rocks; and so, if Archæan, it must belong to one of the latest epochs in that period.

5. "Notes on a part of the Huronian Series in the neighbourhood of Sudbury (Canada)." By Prof. T. G. Bonney.

The specimens noticed by the author were in part collected by him in the summer of 1885, when the Canada Pacific Railway was in process of construction, and in part subsequently supplied to him by the kindness of Dr. Selwyn, Director-General of the Geological Survey of Canada.

The eastern edge of the district assigned to the Huronian consists of rocks, which may possibly be part of the Laurentian series modified by pressure. But after crossing a belt of these, barely a mile wide, there is no further room for doubt. All the rocks for many miles are distinctly fragmental, and are grits, conglomerates and breccias, which are described as far as about two miles west of Sudbury. The included fragments in these rocks appear to have undergone some alterations subsequent to consolidation; these are described. In some cases the changes appear to be anterior to the formation of the fragments. The matrix also has undergone some change, chiefly the enlargement of quartz grains, and the development or completion of mica-flakes, as in the Obermittweida rock.

The author discussed the significance of the changes in these rocks, and states that, in his opinion, the name Huronian, at present, includes either a series of such great thickness that the lower beds are more highly altered than the higher, or else two distinct series; and he inclines to the latter view. Both, however, must be separated from the Laurentian by a great interval of time, and the newer reminds him of the English Pebidians.

## MIDDLESEX NATURAL HISTORY SOCIETY.

The members of this Society held a meeting on the 8th Nov., at the Chandos Rooms, when Dr. Geikie, the Director-General of the Geological Survey, delivered an interesting address illustrative of the necessity of co-operation among fellow-workers in geology, and dealing with some of the difficulties with which geologists are met in explaining some of the problems presented to them. One subject in geology, which he thought was interesting above all others, was the history of topography. He knew no department in the science so absolutely fascinating, and he wished more particularly to call attention to some of the results of denudation, or the operation of the various forces of nature upon the surface of the earth. It was a matter of great importance to be able to study this problem in regions where the rocks had not been disturbed at all by the process to glaciation, and in that respect he wished more particularly of deal with the strip of country extending from the west of Cornwall to the north of the Thames. All over the central and northern parts of the British Islands the surface of the ground had been subjected to the action of ice, and the result had been to smooth the surface and give it a contour very different to that it possessed before the ice settled down upon it. The two characteristics of this kind of contour were the smoothness of the rocks and the ruts which had appeared upon them, showing the action of the ice. In the strip of country from the Severn to the Thames no traces of the action of ice were to be found, and, that being so, what was the condition of things which produced its peculiar contour? That was a problem which continually exercised his mind. One or two questions in connection with it were tolerably clear. In the first place, in that part of England a great thickness of rotted rock was met with, and wherever this rotted material had been acted upon by rain there was a tendency to the formation of rain wash, or brick earth, which might be taken in connection with the valley gravels. In these formations the geologist was often confronted with the difficulty of explaining the collocation in the same deposit of the remains of animals which affected different climates, and in the Thames valley were found both the remains of the hippopotamus, which affected a warm climate, and the mammoth, which affected a cold climate. But from the analogy of the sand dunes these remains need not have been contemporaneous. There were glacial evidences in the south of England to be found in the formation of Selsea Bill, and the valley gravels showed that the rivers were during part of the year frozen. This southern part of England, to which he had referred, was exposed to the influence of air and wind, of washing by rain and of frost, all of which helped to produce its varied contour, and an interesting contrast might be made between that tract of country and the southern portions of Dorset and Devonshire into Cornwall, where there were clays and limestones which bore signs of a long-continued process of denudation. All over that area valleys had been cut out and hills left behind. There were certain dry valleys north of Brighton in which there were no streams and which lay above the water level of the chalk, and it was very difficult to understand by what process those valleys had been excavated. Mr. Reid, of the Geological Survey, had lately suggested that they were excavated during the glacial period, when the soil was frozen hard and the rain and melted snow were able to flow over the surface and denude them. That suggestion had a very high degree of probability in its favour. Such were some of the facts and problems which he had come across in the course of his recent work, and it would easily be seen in how many ways the co-operation of local observers and fellow-workers in the science was desirable.

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## SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

At a recent meeting of the Society, Mr. Edward Stallibrass read a paper on deep-sea sounding in connection with submarine telegraphy. Mr. Stallibrass said the work of surveying with a view to ascertain the configuration of the ocean bed previous to laying a submarine cable was of vital importance. Between Cadiz and Teneriffe alone, a distance of about seven hundred miles, 673 soundings were taken on one expedition, resulting in the discovery of two banks, two coral patches, and four other shoal spots. Some of the inclines near these banks were remarkable for their steepness. On the east side of one of these the bottom fell precipitously for 450 feet, and on a sounding, taken by the *Dacia* during her survey of the Seine bank, a precipice of 1,800 feet was found. A map of the mouth of the Congo showed a most remarkable submarine gully, the contour lines of which were drawn from 202 soundings, many of these having been taken at intervals of less than one mile. In the mouth of this remarkable river a depth of no less than 1,452 feet was found, the Thames in a similar locality giving only about forty feet. The gully was distinctly traced one hundred miles out at sea.

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## REVIEWS.

*The Popular Science Monthly*. November, 1887.

This journal contains as usual a series of thoughtful papers on a variety of scientific subjects, as well as an abstract of a practical character.

The "Unhealthfulness of Basements," by Dr. W. O. Stillman, is a timely protest against the mistake—we might almost say the sanitary sin—of constructing sunk stories, and of living or working in such when built. Man is not, like the mole, the rabbit, or the beaver, a burrowing animal, and for him to adopt underground habits is emphatically a stride in the wrong direction. It is not pleasant to learn that basement dwellings which differ from cellar dwellings only in degree, are quite as common in the cities of America as in those of Europe. The writer points out that basements are usually damp, and that they are in danger of the indraft of contaminated air from leaky sewers, gas-mains, and from the general filth of the subsoil. Another source of mischief which the writer has overlooked, is the comparative absence of sunshine, or indeed, of good daylight. This is a fruitful source of the degeneration of a race. The precautions which the author lays down for preserving basements in a tolerably healthful condition are judicious, but we fear they are too rarely carried out in practice. Among the diseases to which the dwellers in sunk stories are especially subject, the author mentions neuralgia, rheumatism, and consumption. The author has seen many cases of tuberculosis developed in such localities, "particularly noticeable among servant-girls of foreign birth." Here in London we have in this respect very little room to throw stones at New York, for the number of basements here used for living, working, and even sleeping, and the depth of some of them below the level of the street are truly deplorable. It is not generally known, however, that we have in England one large town—Sheffield—perfectly free from this disgrace, unless modern "progress" has quite recently brought them in its track.

Professor E. S. Morse furnishes the second part of a very interesting summary of "What American Zoologists have Done for Evolution." Nowhere has evolution been more cordially accepted as a basis for biological research than in the United States, the only opponent worth mentioning being an eminent *savant*—a Franco-Swiss by birth, who had come to America when already thoroughly saturated with French views. We have here an instance of that power of prediction of which science most fully legitimates her conclusions. We here read that in 1874 Professor Cope predicted that the ancestor of all the mammals would be a five-toed, flat-footed walker, with tubercular grinding teeth. Seven years afterwards he found evidence that such a type had abounded in North America during the Eocene period. This seems to us as great a triumph as the prediction by De Verrier and Adams of the size and position of the planet Neptune before human eye had ever beheld it, or that by Mendelejeff of the properties of the metal gallium before it had been discovered to exist.

The "Chemistry of Oyster Fattening," by Professor W. O. Atwater, exposes a malpractice which closely verges upon fraud, *i.e.*, the custom of placing oysters after being taken from their beds in fresh or brackish water for forty-eight hours. By this means they become plumper and rounder, and increase so in bulk and weight as to command a higher price. The increase, however, is simply water, whilst the actual flesh of the oyster loses about 5 per cent.

An article on "Wedding Rings," by D. R. McAnally, is curious as giving an account of the mystical virtues ascribed to various gems and their suitableness for brides born in the different months. Thus, if a lady had been born in December the gift of a turquoise would insure her constancy; if in May, an emerald would make her a happy wife. "A ring made, it was alleged, from the hoof of the ass which carried Christ into Jerusalem was used in a wedding at a country church near Madrid in 1881."

The most important article in the number before us is "Agassiz and Evolution," by Professor Joseph Le Conte.

As is well known, Agassiz met the doctrine of evolution, as enunciated by Darwin, not merely with hesitation and doubt, but with an emotional opposition. This position, on the part of one who had done such splendid work in biological science, and who had before him essentially the very same evidence which had guided Darwin and Wallace, naturally occasioned no little surprise and regret, and various suggestions have been put forward to account for his conduct. If we set aside such unworthy motives as jealousy, the most probable hypothesis is one put forward by our late friend, Dr. G. M. Beard, of New York, in a work entitled, "Legal Responsibility in Old Age." Said he, with reference to the death of Agassiz: "The intemperate manner of his opposition to the theory of evolution, by which he was so rapidly winning favour among the thoughtless and ignorant, and so rapidly losing favour among the conscientious and scholarly, may find its partial, if not complete, explanation in the exhausted condition of his brain."

Professor Le Conte, however, takes a very different view. The main purport of his memoir is to palliate, if not to justify, the error of Louis Agassiz, to whom, he thinks, scant justice has been done, "especially by the English and the Germans." He refused to accept evolution "because his religious intuitions forbade." Now this plea, if it be accepted on behalf of Louis Agassiz, must be equally valid in defence of the opponents of Roger Bacon, of Bruno and Galileo. At the same time Professor Le Conte admits that Agassiz was wrong in supposing that there was any conflict between evolution and the theistic conception of the universe.

The relation of Agassiz to Darwin he likens to that of Kepler to Newton. But would Kepler, had he been still living, have opposed Newton? We trow not. The position of Agassiz resembles rather that of Priestley, who, having discovered oxygen, remained the champion of the phlogistic system, thus still seeking to defend the fort whose ramparts he had breached.

We regret that Professor Le Conte should speak of Cuvier as "the greatest naturalist of that or perhaps of any time." Cuvier, though a diligent and successful discoverer of details, was incapable of any true philosophic generalisation. We cannot call him "the great founder of comparative anatomy" without doing injustice to John Hunter.

Here, however, we regret that we must abruptly close our notice of Professor Le Conte's most important memoir.

*Transactions of the Institution of Naval Architects.* Vol. 28. Edited by George Holmes, Secretary of the Institution. 1887. Office: 5, Adelphi-terrace, London, W.C. Sold by Henry Sotheran and Co., 36, Piccadilly, London, W.; J. Barr and Co., Paris, and Frankfort-on-the-Main.

The transactions are of the proceedings at Liverpool in July, 1886, and in London in March, 1887. The Liverpool proceedings cover the President's address; a paper on the carriage of petroleum in bulk on over-sea voyages, by B. Martell, Esq., Chief Surveyor to Lloyd's Register of British and Foreign Shipping, member of Council; a paper describing the river Mersey and the port of Liverpool, by G. Fosbery Lyster, Esq., Chief Engineer Mersey Dock and Harbour Board, associate; notes upon losses at sea, by F. Elgar, Esq., LL.D., F.R.S.E., Director of Royal Dockyards, member of Council; a paper on the progress and development of marine engineering, by W. Parker, Esq., Chief Engineer, Surveyor to Lloyd's Register of British and Foreign Shipping, member of Council; and a paper on Atlantic steamers, by W. John, Esq., member of Council. The discussion which followed each paper is given, and a report of the preliminary proceedings closes the transactions. The London proceedings contain the President's address; a paper on the Merchant Service and the Royal Navy, by Sir Nathaniel Barnaby, K.C.B., Vice-President; a communication relating to the results of a series of progressive trials carried out at Cherbourg on a torpedo boat, by Mons. L. de Bussy, honorary member; a paper on the twin-screw torpedo vessels *Wiborg* and *Destructor*, by J. H. Biles, Esq., member; a paper on fifty years of yacht building, by Dixon Kemp, Esq., associate member of Council; a paper on the corrosion of iron and steel ships, by Vivian B. Lewes, Esq., associate; a paper on fuel supply in ships of war, by Sir Nathaniel Barnaby, K.C.B., Vice-President; a paper on the changes of level in the surface of the water surrounding a vessel, produced by the action of a propeller and by skin friction, by Professor J. H. Cotterill, F.R.S., associate member of Council; a paper on the forces acting upon the blade of a screw propeller, by G. A. Calvert, Esq., member; a paper on the machinery of small boats for ships of war, by A. Spyer, Esq., member; a paper on the comparative effects of belted and internal protection upon the other elements of design of a cruiser, by J. H. Biles, Esq., member; a paper on the shifting of cargoes, by Professor P. Jenkins, member; a paper on the practical application of stability calculations, by Archibald Denny, Esq., member; a paper on the principle of an hydraulic apparatus for transmitting signals and power, and controlling all sorts of distant mechanism, by Mons. Marc Berrier Fontaine, member; a paper on some recent high-speed twin-screws, by E. A. Linnington, Esq., member; a paper on the forms of fish and ships, by Professor R. H. Thurston, associate; a paper on a new method of using paper sections for the determination of cross curves of stability, by J. H. Heck, Esq., member; and last, a paper on stability calculations by means of the planimeter, by L. Benjamin, Esq., member. As before, the discussion which followed each paper is given. The concluding matter is made up of sundry speeches.

Such are the transactions. From a scientific point of view the mass is formidable. Were it within the present space means of this journal to furnish comprehensive abstracts of the matter of the series, an undoubted service would be rendered to the general scientific public. An attempt in this direction may be shortly made. It is an acknowledged want with a variety of subjects of permanent interest which are constantly being submerged to the retardation of that dissemination of fact and theory which is so much longed for. A like remark applies to the matter of scientific books generally, the desire for which is universal, especially in a form at once readable and concise. Meanwhile we take leave of the transactions, which are in a high degree creditable to the contributors and their editor.

*Civil and Mechanical Engineering, Popularly and Socially Considered.* By J. W. C. Haldane, C.E. and M.E. With nine plates. London: E. and F. N. Spon, 125, Strand; New York: 35, Murray Street. 1887.

This is a book which should be read by those on whom rests the responsibility of suggesting or providing occupations or professions for boys. It is a book also for those who seek pleasure in the stories and experiences of a long life spent in civil and mechanical engineering. On the other hand, it is not a scholarly book, and sometimes it sins against taste. The personality of the author is too frequently brought out; and it would almost seem, from the rather loose style of some pages, and the close, exact style of others, that more than one hand has been engaged upon the text. This, while a literary blemish, is not likely to interfere with the general appreciation which the volume merits, and which doubtless it will receive. Steam Navigation and Canals and Railways is the heading of the first chapter, and its information is typical of the treatment of the various subjects throughout the volume. Mr. Miller, of Dalswinton, introduced steam navigation in miniature form in 1788. The *Comet* navigated the Clyde by steam in 1812. In 1825 the merchants of Calcutta offered the premium of a lac of rupees to whomsoever would make, by steam, the out and home Indian voyage, the time to "average" seventy days each way. Maudslay, as the result of this temptation, proceeded to fit out the paddle steamer *Enterprise*, of 470 tons and engines of 120 horse-power, and eventually the ship sailed, but with so many vital defects in machinery and arrangement that it is a marvel that the passage was ever made. The cylinders and boiler were unprotected, and so intense at times became the heat of the stoke-hole, that neither stokers nor engineers could withstand it. The entire cargo consisted of coal and stores for an expected run of thirty-five days to the Cape, and some of the coal in bags being stowed upon the boiler, it caught fire and was with difficulty extinguished. The average speed on the voyage was five knots an hour, and the time occupied was one hundred and fourteen days, forty of which were under sail and eleven at anchor. The commander, Lieutenant Johnston, R.N., received £10,000 for his arduous services. This was in 1825, and taking this as the first advance in steam navigation, the author follows on with the gradual development of steam navigation to the present time, the subject being spread over several chapters, each of which is stored with fact, comment, and story.

Apprentices gain admission into shipbuilding and engineering works in one of three ways—first by influence, second by money, and third by both. Examples of the working of the three methods are one of the excellent features of the volume. Generally, in England, money payments are required, but in Scotland lads generally are received without payment. It is not stated whether this difference is of recent origin, but presumably it is, and probably the present concentration of shipbuilding on the Clyde accounts for a rule in Scotland which hereafter may be acted upon in England. The Scotch shipbuilder and engineer has found the gentleman apprentice, with even his £1,000 premium, to be a nuisance, and accordingly he will have no more of him. He receives a lad willing and able to work, whom he will help forward for his own sake, should the lad show "that he has grit in him." Nasmyth's life is a case in point. His father, taking the boy with him, left Leith in a sailing smack for London in 1829, and the voyage was made in four days. Mr.

Nasmyth's errand was to apprentice his son to Messrs. Maudslay and Field. To his dismay, the firm had ceased to take pupils, thereby anticipating the present Scotch rule. Sympathetic Mr. Maudslay, before dismissing his visitors, took them for a ramble through the works, when the bent and genius of the lad could not be restrained. He personally begged that Mr. Maudslay would take him in any capacity he pleased. "So you are one of that sort, are you?" said Mr. Maudslay. "Bring your drawings and models to-morrow at twelve, and let me see them." Such was the beginning of James Nasmyth. In Scotland boys begin in like manner, and by application may attain to excellence, if not to eminence. When they were taken with premiums they did as they liked, and as a rule learned nothing that would command positions afterwards.

## TECHNICAL EDUCATION.

City and Guilds of London Institute.—At a recent meeting of the Council, a letter was read from Miss Anna Louisa Cohen and Miss Lucy Cohen, offering one thousand pounds to found a Scholarship in connection with the Central Institution, in memory of their uncle, the late Mr. John Samuel, one of the first members of the Executive Committee. The offer was accepted.

Carriage Building.—The Council of the Institute of British Carriage Manufacturers has approved and issued to its members a syllabus of instruction for young men preparing to engage in carriage manufacture. This syllabus includes lists of subjects suitable for employers, for managers, and foremen; for accountants, clerks, etc., and for skilled artisans. The subjects of general education required for the foremen include reading, writing, arithmetic, drawing, mechanics, metallurgy, book-keeping, geography, and one foreign language. The accountant classes are expected, in addition to these, to have a knowledge of commercial law, shorthand, type-writing, the arrangements necessary in the packing and shipping of carriages. No technical instruction is set down for them. Rather higher general education is required from managers and foremen, while the syllabus for employers includes also elementary engineering, elements of botany and forestry, animal and vegetable substances used in the manufacture, contrast and harmony of colours, etc. The technical subjects required from the artisans depend upon the class of work on which they are engaged, varying according as the artisans are workers in wood, smiths, painters, or trimmers. The technical education for employers includes the principles of designing and constructing carriages, in whole or in part, mechanics, knowledge of qualities and characters of woods, and a knowledge of the varieties of carriages used in different parts of the world.—*Journal of the Society of Arts.*

The Horological Institute.—The Council of this Institute offer a prize of seven guineas for the best, and a prize of three guineas for the second best practical essay on "Modern methods of turning, drilling, boring, pivoting, and polishing applicable to watch work, by means of modern appliances, and either the hand or foot wheel." Papers in competition to reach the Secretary of the Horological Institute, Northampton Square, Clerkenwell, not later than Monday, April 30th, 1888. Each paper must be distinguished by a *nom de plume* or motto, and be accompanied by a sealed envelope bearing a similar mark, and containing the name of the competitor. Practical classes in connection with this Institute are held at Northampton Square, Clerkenwell, on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, from 10 till 5. The class for instruction in mechanical drawing in relation to Horology is held on Tuesday evenings, from 6 till 7.30 o'clock, and on Thursday evenings from 8 till 9.30, during the winter. The elementary class for theoretical horology and mechanics is held on Tuesday evenings, from 8 till 9.30; and on Thursday evenings, from 6 till 7.30, during the winter.

Education in the Army.—The War Office has appointed a committee to report upon the present system of technical education amongst officers of the Army, and to make suggestions as to reforms in the present course of instruction, with a view of making the practical education of a young officer more complete. The committee, which is expected to meet shortly, is under the presidency of General H. A. Smyth, Royal Artillery.

India.—Twenty thousand rupees have been given by the Maharanee of Cossimbazar for the promotion of technical education in the Moorshedabad district. Five thousand are to be spent in purchasing the necessary apparatus and instruments, and the interest on the remainder is to be devoted to endowing a class in the Berhampore Collegiate School and establishing classes in connection in some of the elementary schools in the vicinity.

Coventry.—It is expected that, in connection with the Horological Institute and City and Guilds of London Institute, a Technical School will be opened at Coventry shortly.

Leicester.—The Technical Schools have commenced their sessions with extremely encouraging prospects; more students, and a generally enhanced interest in their work, encourage hopes of a more successful winter's work than any preceding one. The prizes were distributed a few days ago to the successful students of last session by Mr. Swire Smith, one of the Royal Commission on this subject, who spoke highly of the work of the Institution. Practical examinations were held in plumbers' work. The total number of students in the various classes was 243, with an average attendance of 173, and 198 entered for the examinations of the City and Guilds of London Institute.

Newcastle.—Mr. Miles Settle has given the sum of £100 to the Governors of the Newcastle Endowed Schools, to found a prize for proficiency in scientific attainments necessary for the profession of a mining engineer. During the winter months scientific lectures on practical mining are to be given at some of the large collieries in the district, and a convenient laboratory is being fitted up for the benefit of the miners employed in the pits. The result of such efforts as these to spread a knowledge of the properties and constituents of gases, the principles of ventilation, and the formation of the minerals worked, should have a tendency to reduce the number of accidents in mines.

Preston.—The Harris Trustees, Preston, have granted out of the funds at their disposal £30,000 towards the furnishing and endowing of a technical school for Preston. Of this £10,000 only can be spent upon the building and furnishing. The Preston Corporation have consented to provide a central site, and they are to be memorialised for a grant of £10,000 in addition.

Worcester.—It has been recently resolved to unite within one large building the various art, science, and educational societies of the city at a cost of something like £20,000.

## RECORD OF SCIENTIFIC AND TECHNICAL SOCIETIES.

⁂ *The whole of the papers of the Societies referred to are not included in this list.*

### THE ROYAL SOCIETY.

Nov. 17.—Papers read, "Preliminary Note on the Spectra of Meteorites," by Mr. J. Norman Lockyer. "On the Classification of the Fossil Animals commonly named Dinosauria," by Prof. H. G. Seeley; "Specific Inductive Capacity," by Dr. J. Hopkinson.

### INSTITUTION OF CIVIL ENGINEERS.

Nov. 15.—Paper read, "Accidents in Mines, II.," by Sir F. A. Abel.

Nov. 18.—Paper read, "Boiler Experiments and Fuel Economy," by Mr. J. Holliday.

### THE SOCIETY OF ARTS.

Nov. 23.—Paper read, "The Mercurial Air-pump," by Prof. Silvanus P. Thompson.

### ROYAL METEOROLOGICAL SOCIETY.

Nov. 16.—Papers read, "The use of the Spectroscope as an Hygrometer, Simplified and Explained," by Mr. F. W. Cory; "Rainfall on and around Table Mountain, Capetown, Cape Colony," by Mr. J. G. Gamble; "On the Cause of the Diurnal Oscillation of the Barometer," by Mr. R. Lawson.

### ROYAL MICROSCOPICAL SOCIETY.

Oct. 12.—Papers read, "Twenty-four New Species of Rotifera," by Mr. P. H. Gosse.

Nov. 9.—Papers read, "Observations on the Metamorphoses of Amœbæ and Actinophrys," by Mr. C. R. Beaumont; "Synopsis of the Recent British Foraminifera," by Mr. H. B. Brady.

### SOCIETY OF CHEMICAL INDUSTRY,

Nov. 7.—Paper read, "Note on the Comparative Antiseptic Action of Chlorides, Nitrates, and Sulphates," by Mr. C. T. Kingzett.

### THE GEOLOGICAL SOCIETY.

Nov. 9.—Papers read, "Note on the so-called 'Soapstone' of Fiji," by Mr. H. B. Brady; "On some Results of Pressure and of Intrusive Granite in Stratified Palæozoic Rocks, near Morlaix, in Brittany," by Prof. T. G. Bonney; "On the Position of the Obermittweida Conglomerate," by Prof. T. McK. Hughes; "On the Obermittweida Conglomerate: Its Composition and Alteration," by Prof. T. G. Bonney; "Notes on a part of the Huronian Series in the neighbourhood of Sudbury, Canada," by Prof. T. G. Bonney.

Nov. 23.—Papers read, "Note on a New Wealden Iguanodont, and other Dinosaurs," by Mr. R. Lydekker; "On the Cae-Gwyn Cave," by Prof. T. McK. Hughes; "Further Observations on the Drifts of North Wales," by Prof. T. McK. Hughes.

### SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

Nov. 10.—Paper read, "Deep-sea Sounding in Connection with Submarine Telegraphy," by Mr. E. Stallibrass.

Nov. 24.—Papers read, "On some Instruments for the Measurement of Electromotive Force and Electrical Power," by Dr. J. A. Fleming; "Portable Voltmeters for Measuring Alternating Potential Differences," by Profs. W. E. Ayrton and J. Perry.

### SOCIETY OF ENGINEERS.

Nov. 7.—Paper read, "Primary Batteries for Illuminating Purposes," by Mr. Perry F. Nursey.

### LIVERPOOL ENGINEERING SOCIETY.

Nov. 9.—Paper read, "Automatic Weighing," by Mr. H. Pooley, jun.

Nov. 19.—Paper read, "Ornament and Design in Engineering Works," by Mr. C. H. Townsend,

### THE MINING ASSOCIATION AND INSTITUTE OF CORNWALL.

Oct. 25.—Paper read, "Foreign Mining Laws," by Mr. A. Strauss.

Nov. 21.—Paper read, "The Advantage of Ore-dressing by Automatic Machinery," by Mr. H. W. F. Kayser.

### CHEMICAL SOCIETY.

Nov. 17.—Paper read, "The Halogen Substituted Derivatives of Benzalmalonic Acid," by Mr. C. M. Stuart.

### PHYSICAL SOCIETY.

Nov. 12.—Papers read, "The Rotation of a Solid Copper Sphere and of Copper Wire Helices when freely suspended in a Magnetic Field," by Dr. R. C. Shettle; "A Geometrical Method of Determining the Conditions of Maximum Efficiency in the Transmission of Power by Alternating Currents," by Mr. T. H. Blakesley.

## SCIENTIFIC MEETINGS AND EXHIBITIONS.

MUNICH EXHIBITION.—The Bavarian Association of Industrial Art has (according to the *Sprechsaal*) organised an exhibition to be held at Munich from May to October, 1888, the principal object of which is to display the progress made during the last twelve years of German industrial art. The development of art in Germany will be represented, from an historical point of view, by the fitting up of a series of rooms in the styles of the principal artistic epochs.

SCANDINAVIAN EXHIBITION.—Arrangements have been made for holding a Scandinavian Exhibition at Copenhagen next spring. Active steps are being taken in Denmark in order to have a thoroughly complete display of Danish products and manufactures, and Norway will be fully represented. There will also be contributions from Finland and a separate division for exhibits from other countries.

WIESBADEN NATURAL SCIENCE EXHIBITION.—At the exhibition opened on the occasion of the sixtieth annual meeting of the German naturalists and doctors, the photographic department was a success, both in regard to the quality of the exhibits and the number of exhibitors. The renowned optician, Zeiss, of Jena, showed a most ingeniously constructed apparatus for photo-micrography, permitting the magnifying of the object 4,500 diameters, provided with electrical arc light, and an arrangement for cooling the condensers by water. Astronomical photographs were shown by E. von Gothard, of Hereny (Hungary) and photographs of shining clouds by Dr. Stoltze, of Berlin.

HUNGARIAN EXPORT MUSEUM.—A permanent museum of Hungarian products is about to be opened in Belgrade. There will also be a ship, which will be a floating museum of Hungarian samples of all kinds, to visit Bombay, Madras, Calcutta, Singapore, Saigou, and the principal Chinese and Japanese ports.

ITALIAN EXHIBITION IN LONDON.—It is proposed to open in the course of next year an Italian Exhibition on the premises lately occupied by the American Exhibition.

THE ROYAL SOCIETY.—The following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1888, at the forthcoming anniversary meeting on the 30th inst.:—President: Professor George Gabriel Stokes, M.A., D.C.L., LL.D. Treasurer: John Evans, D.C.L., LL.D. Secretaries: Professor Michael Foster, M.A., M.D.; Lord Rayleigh, M.A., D.C.L. Foreign Secretary, Professor Alexander William Williamson, LL.D. Other members of the Council: Sir William Bowman, Bart., M.D., Henry Bowman Brady, F.L.S., F.G.S., Professor Arthur Cayley, D.C.L., LL.D., W. T. Thiselton Dyer, M.A., Professor David Ferrier, M.A., M.D., Edward Frankland, D.C.L., Arthur Gamgee, M.D., Professor Joseph Henry Gilbert, M.A., Professor John W. Judd, P.G.S., Professor Herbert McLeod, F.I.C., William Pole, Mus. Doc., William Henry Preece, M.I.C.E., Admiral Sir George Henry Richards, K.C.B., Professor Arthur William Rücker, M.A., The Earl of Rosse, D.C.L., LL.D., Sir Bernhard Samuelson, Bart., M.I.C.E.

PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN.—At the first ordinary meeting for the winter session, James Glaisher, F.R.S., President, in the chair, medals were presented to Messrs. G. P. Cartland, Harvey Tolley, H. P. Robinson, T. A. Green, H. C. Pettitt, J. F. Roberts, W. J. Byrne, Frederick Müller (Munich), Andrew Pringle, Boussod Valadon and Co., P. H. Emerson, Annan and Swan, J. B. B. Wellington, F. H. Evans, F. M. Sutcliffe, W. H. Hyslop, Arundell and Marshall, Eastman Dry Plate and Film Company, and J. Gale.

ASTRONOMICAL SOCIETY OF FRANCE.—A society has been founded under the above title for the purpose of promoting the development of astronomy and facilitating its study. The ordinary meetings are held monthly in Paris.

SOCIETY OF ARTS.—A paper will shortly be read by Sir Howard Grubb on "Telescopes for Stellar Photography." Mr. Walter Crane's lectures on the "Decoration and Illustration of Books," will be delivered on the evenings of April 9th, 16th, and 23rd, 1888. Mr. John Mayall, junr., will continue his recent course of discourses on the "Microscope," the dates being February 27th and March 5th.

ROYAL SCOTTISH SOCIETY OF ARTS.—At the annual general meeting, held on November 14th, after the President's address, medals were presented to Messrs. W. Forgan, W. A. Carter, M.Inst.C.E., G. R. Primrose, and W. Bennett. Prizes were given to Messrs. J. Stephen, M. Moore, and H. Booth. The following officers were appointed: President, Dr. F. B. Imlach; Vice-presidents, Dr. W. Taylor, Dr. A. Stevenson; Councillors, J. M. Bryson, E. Mather, D. Menzies, J. S. Wyllie, and W. B. Blackie.

ZOOLOGICAL SOCIETY.—At the evening meeting held on Nov. 15, the President (Professor Flower) referred to the recent important acquirement of a living gorilla, about three years of age. The specimen was purchased at the beginning of October, and was then suffering from the fatigues of its journey. It has now attained to healthy condition, and is very interesting. Amongst the several communications read was a letter from Emin Pacha, offering to the Society such zoological collections as he had been enabled to make, as soon as a means for their despatch could be arranged.

CARDIFF NATURALISTS' SOCIETY.—Mr. John Storrie, Curator of the Cardiff Museum, has issued, under the auspices of this Society, a valuable descriptive list of the indigenous plants found in the neighbourhood of Cardiff, with a list of the other British and exotic species found on Cardiff Ballast Hills.

BERLIN ETHNOLOGICAL MUSEUM.—It is reported that Dr. Schliemann has made a will, leaving his very valuable collection at Athens to this institution.

## APPLICATIONS FOR LETTERS PATENT.

*The following selected list of applications has been compiled especially for the* SCIENTIFIC NEWS, *by Messrs.* W. P. THOMPSON *and* BOULT, *Patent Agents, of* 323, *High Holborn, London, W.C.; Newcastle Chambers, Angel Row, Nottingham; Ducie Buildings, Bank Street, Manchester; and* 6, *Lord Street, Liverpool.*

No.

12907.—HORACE ROBINSON, 12, Albert Street, Manchester. "Hot-air engines." 23rd September, 1887.

12946.—WILLIAM GUEST, TOM GUEST, GEORGE GUEST, and ARTHUR GUEST, 34, Copper Street, Mapplewell. "Invention to take the waste gases from coke ovens to fire boilers and light work, and to make shale and waste dirt into oxide of iron and calcine and creosote oil." 24th September, 1887.

12947.—FREDERICK NICOLADIES PRIESTLEY and MAHLON HIRST, Sunbridge Chambers, Bradford. "Forming the connecting joints between jack-levers and blades of wytch engines." 24th September, 1887.

12966.—WILLIAM PHILLIPS THOMPSON. A communication from Schiffer and Kircher, Bavarian Palatinate. "Grinding, cleaning, and sorting apparatus." 24th September, 1887.

12982.—CHARLES KNIGHT, 108, High Street, Newport, Isle of Wight. "Automatically supplying oil or spirits to lamps, or for supplying any fluids automatically from a tank or cistern to another vessel." 26th September, 1887.

12994.—CARL BRADER, 4, St. Ann's Square, Manchester. "Coverings for steam or hot-water pipes, cylinders." (Complete specification.) 26th September, 1887.

13000.—DAVID PARSONS, DAVID JOHN PARSONS, JOSEPH HENRY PARSONS, and SAMUEL JESSE PARSONS, 128, Colmore Row, Birmingham. "Automatic feed water regulators for steam boilers." 26th September, 1887.

13014.—EDWIN ALBERT HAYES, 328, West Fifty-seventh Street, New York, United States. "Bags for distributing oil on water." 26th September, 1887.

13019.—JOSEPH HILL, WILLIAM SMITH, and JOHN PATRICK O'DONNELL, Cambridge Road, New Malden, Surrey. "Working and ground-interlocking of railway point and signal apparatus." 26th September, 1887.

13025.—JOSEPH ALFRED FISHER and LAWRENCE BOOTH, 28, Southampton Buildings, Chancery Lane, W.C. "Fire-proof curtains or screens for theatres and other public buildings." 26th September, 1887.

13056.—WILLIAM ALDRED, Gray's Inn Chambers, 20, High Holborn, W.C. "Electro-magnetic motors." 27th September, 1887.

13080.—WALDEMAR FRITSCHE, 45, Southampton Buildings, London. "Dynamo-electric machines." 27th September, 1887.

13094.—JOHN YOUNG SHORT, 70, Chancery Lane, W.C. "Construction of torpedo and other vessels." (Complete specification.) 27th September, 1887.

13110.—AUGUSTUS HARRIS and JAMES BALLANTYNE HANNAY, 87, St. Vincent Street, Glasgow. "Theatre curtains designed to prevent the spreading of fire." 28th September, 1887.

13124.—WILLIAM BRUCE THOMPSON, 82, High Street, Dundee. "Strengthening steam and feed pipes for use in marine and other engines." 28th September, 1887.

13128.—JOSEPH PREGARDIEN, Barmen, Germany. "Self-acting regulating valve for steam and other pipes." 28th September, 1887.

13147.—JAMES O'KELLY and BERNARD AMBROSE COLLINS, 23, Southampton Buildings, W.C. "Torpedoes, and in apparatus connected therewith." 28th September, 1887.

13159.—WILLIAM WALLACE DUNN, 45, Southampton Buildings. "Electro-motors and dynamo-electric machines." 28th September, 1887.

13232.—ARTHUR EDWARD PORTE, 43, Great Brunswick Street, Dublin. "Communicating with a railway train in motion." 30th September, 1887.

13237.—CLEMENT HOLDSWORTH and JOSEPH HORTON, Commercial Street, Halifax. "Improved mechanism for changing the shuttles in looms for weaving." 30th September, 1887.

13245.—EMIL GRAEFE, 89, Chancery Lane, W.C. "Placing railway trains in communication with an electric conductor separate therefrom." (Complete specification.) 30th September, 1887.

13309.—CHARLES VANDELEUR BURTON, 24, Wimpole Street, London, "New dynamo-electric machine." 1st October, 1887.

13312.—JOHN ALFRED RADLEY, Pelham House, Old Nelson Street, Lowestoft. "Apparatus for dredging by suction or pumping." 1st October, 1887.

13374.—JOHN MACDONALD, 96, Buchanan Street, Glasgow. "Explosive projectiles or shells for artillery and other guns." 3rd October, 1887.

13404.—ROBERT YOUNGER, Victoria Villa, Heaton, Newcastle-upon-Tyne. "Slotting and shaping machine tools." 4th October, 1887.

13729.—BERNARD STANIFORTH HARRISON, Unston Steel Works, Dronfield, near Sheffield. "Making scythe blades." 11th October, 1887.

13734.—KATE RACHEL KILBOURN, 55 and 56, Chancery Lane, W.C. "Generating heat." 11th October, 1887.

13736.—ALONZO SMITH KIMBALL and GEORGE LOOMIS BROWNELL, 52, Chancery Lane, W.C. "Electric spinning and twisting machines." (Complete specification.) 11th October, 1887.

13745.—FRANCIS ROBERT BAKER, 4, Cherry Street, Birmingham. "Extinguishing apparatus for hydro-carbon and other oil lamps." 11th October, 1887.

13746.—BENJAMIN JOSEPH BARNARD MILLS. A communication from Thomas B. Fogarty, United States. "Manufacturing ammonia." (Complete specification.) 11th October, 1887.

13758.—ALFRED JULIUS BOULT. A communication from Smith and Rimble. "Electrical apparatus especially applicable for use in dental operations. (Complete specification.) 11th October, 1887.

13797.—WILLIAM WILEY, 36, Lancaster Street, Birmingham. "Syringes for hypodermic injections." 12th October, 1887.

13858.—JEAN BAPTISTE ROTTENSTEIN and HENRY ANDREW COUSINS, 55 and 56, Chancery Lane, W.C. "Inlaid designs or letters in artificial marble and like substances." 13th October, 1887.

13884.—ARCHIBALD MCLEAN GORDON, 89, Wigmore Street, Cavendish Square. "Bullet Extractor" (electrical). 13th October, 1887.

13926.—WILLIAM HENRY PENNING and HUGH GWYNNE OWEN, 11, Wellington Street, Strand. "Saving fine or flour gold in milling, hydraulicing, and sluicing." 14th October, 1887.

13967.—WALTER THOMAS GOOLDEN and ALEXANDER PELHAM TROTTER, 23, Andalus Road, Clapham, S.W. "Brushes and their holders for dynamo-electric generators and motors." 14th October, 1887.

13978.—ANDREW NOBLE, Jesmonddene House, Newcastle-on-Tyne. "Electric firing gear for rapid firing and other guns." 14th October, 1887.

13999.—JAMES STURROCK, *Dundee Advertiser* Office, Dundee, Forfarshire. "Photographic photometer." 15th October, 1887.

14009.—ALFRED JULIUS BOULT. A communication from Leopold Bon, Cuba. "Cutting sugar-cane." 15th October, 1887.

14054.—DESMOND GERALD FITZ-GERALD, 6, Akerman Road, Brixton. "Electro-chemical process for the extraction of the precious metals from their ores." 17th October, 1887.

14069.—THOMAS MELVIN, 1, Jasmine Villas, Northumberland Park, Tottenham. "Pulley block, with automatic check action, for raising, lowering, and sustaining weights at any height." 17th October, 1887.

14094.—HERBERT JOHN ALLISON. A communication from Leopold Cohn, United States. "Atomizers and in devices for operating the same." (Complete specification.) 18th October, 1887.

14107.—NORCLIFFE GEORGE THOMPSON, 4, Queen Victoria Street, London. "Continuous current commutatorless dynamo." 18th October, 1887.

14126.—ALFRED JULIUS BOULT. A communication from Jean Pierre Roger, France. "Lawn mowers." 18th October, 1887.

14143.—GEORGE RICHARD HILDYARD, 169, Fleet Street, E.C. "Artistic lithography." 18th October, 1887.

14150.—JOSEPH COATES, 166, Fleet Street, E.C. "Reduction of ores by stamps." 18th October, 1887.

14180.—MATTHEW RAYMOND and FRANK RAYMOND, 7, Maidenstone Terrace, Point Hill, Blackheath, S.E. "Railway engines and trains, spring bolts, shunting couplings." 19th October, 1887.

14196.—HENRY MERCER GIRDWOOD, 4, Mansfield Chambers, 17, St. Ann's Square, Manchester. "Retting, ungumming, washing, and otherwise treating Rhea Ramie or china grass, hemp, jute, flax, and certain other fibres." 19th October, 1887.

14204.—JOHN RANDOLPH HARD and THOMAS WILSON, 191, Fleet Street, E.C. "Contact and binding devices for electrical apparatus." (Complete specification.) 19th October, 1887.

14241.—WILLIAM HENRY WATKINSON, Mytholmes, Haworth, Keighley, Yorkshire. "Hydraulic transmission of power, applicable also for telegraphic purposes." 20th October, 1887.

14259.—CHARLES HALL and HENRY BINKO, 2, Peter's Lane, Cowcross Street, E.C. "Application of primary batteries for electric signals, telephones, lights, or other purposes." 20th October, 1887.

14290.—THOMAS EDWARD WILSON, 28, Southampton Buildings, Chancery Lane, W.C. "Automatic appliance for protection against fire." 20th October, 1887.

14310.—JOHN WILSON, 62, St. Vincent Street, Glasgow. "Lace-making machines." 21st October, 1887.